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CONTENTS.

PAGE

Contrasts in Bavaria. By GRENVILLE A. J. COLE, M.R.I.A., F.G.S. 121

Modern Pisciculture: Being a Description of the Solway Fishery. By T. A. GERALD STRICKLAND. (*Illustrated*) 123

The Evolution of Simple Societies.—III. The Pastoral Societies. By Prof. ALFRED C. HADDON, M.A., SC.D., F.R.S. 126

The Royal Academy Exhibition 128

Artificial "Reseau Photospherique." By the Rev. ARTHUR EAST. (*Illustrated*) 129

Photographs of the Nebulæ M. 8 Sagittarii and of μ Vl. Ceti. By ISAAC ROBERTS, D.SC., F.R.S. 132

Nebulæ M. 8 Sagittarii and μ Vl. Ceti. (*Plate*)

Astronomy without a Telescope.—V. Observations of the Sun. By E. WALTER MAUNDER, F.R.A.S. ... 132

Letters:

SEARCH FOR AN INTRA-MERCURIAL PLANET. By W. F. DENNING 134

S. U. CYGNI. By DAVID FLANERY 134

WIRELESS-TELEGRAPH RECEIVER. By R. CHILD BAYLEY 135

Notices of Books 135

BOOKS RECEIVED 137

The First Musk-Oxen in England since the Glacial Epoch. By R. LYDEKKER. (*Illustrated*) 137

Chemical Evolution: A Chapter of History. By G. CECIL FRY 139

Microscopy. By JOHN H. COOKE, F.L.S., F.G.S. 141

Notes on Comets and Meteors. By W. F. DENNING, F.R.A.S. 142

The Face of the Sky for June. By A. FOWLER, F.R.A.S. 143

Chess Column. By C. D. LOCOCK, B.A. 143

CONTRASTS IN BAVARIA.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

CERTAIN cities, such as Munich and Nuremberg, certain highland resorts in the south, commonly associated in the tourist mind with Tyrol—these are all that the name Bavaria conveys to us in ordinary conversation. Lovers of the arts may add Bayreuth, far away in the north, planted against the granite knot of the Fichtelgebirge; while travellers to Vienna may remember something of the Danube plain, and of the banks of willows between Regensburg and Vilshofen. Bavaria, however, with its plateaux and its devious by-ways, offers a variety of geological features, and is rich in scenic contrasts.

The country, on the other hand, has its drawbacks, which mainly arise from the stolid nature of a prolific and inebriate peasantry; but greater life and lightness are introduced into the community in proportion as one nears the Austrian border. Doubtless the chief charm of the country lies in the quaintness of its towns; but the sites of these, and much of their character, depend upon their geological surroundings.

The great feature of northern Bavaria is the series of plateaux which rise from the left bank of the Danube above Kelheim, and which stretch, under the names of the Rauhe Alb and the Swabian Jura, south-west through Württemberg to the Rhine. After a step down to the north-west, a still broader plateau-country spreads away northward to the Main. As in our own chalk districts, the gentle dip of the strata is accountable for the prevalence of one type of country over so broad an area. The upland of the Swabian and Franconian Jura is formed of Jurassic strata, which run north-east from Stuttgart to near Nuremberg, and then swing round to the north; Nuremberg itself, and many other busy towns, stand on the next plateau, that of the Keuper, which rises with the gently inclined beds to some 1,500 feet above the sea. Viewed broadly, then, we encounter here two systems of strata, the more northern dipping under that which lies to the south and east. The Keuper, with its other Triassic associates, does not reappear until we find its marine representatives upturned and contorted on the flanks of the Alpine chain. The Jurassic beds similarly vanish, as they dip down towards the Danube, to come up again in the Alpine foothills; and the wide basin formed on their backs is filled by Cainozoic deposits, many of them marine, and mostly of Miocene age. Into this lowland, the growing Alps sent down their detritus, and the Miocene beds have been covered in turn by vast glacial and alluvial accumulations.

The northern plateaux form a somewhat irregular watershed. The rivers rise mostly on the surface of the Keuper, in which they have cut deep grooves; but it is difficult to judge, when we cross any one of them, to which system of drainage it belongs. The Kocher, for example, draws much of its water from the higher step, the Jurassic plateau, but escapes down the escarpment and runs across the Keuper to the Neckar, and thence into the Rhine. The Wornitz, a little further east, rises on the Keuper plateau, cuts south across the Jurassic beds, and joins the Danube at Donauwörth. The Altmühl, its next neighbour on the east, takes a similarly determined course; but the Rednitz, starting in the same direction, swings entirely round below Ansbach, runs due north, and joins the Main at Bamberg. All this points to the lack of conspicuous guiding lines in this region of almost horizontal plateaux.

Though we travel here all day at a height of some 1200 feet above the sea, there is little to suggest the elevation. As we rise from the valley of the Neckar, we wind this way and that, for purely agricultural convenience, across a country of great unfenced fields; here and there a scarp, the next step on the plateau, stands more seriously against us, with some fortress-town, like Waldenburg, planted on its level crest. The purple crocus flourishes in the meadows, a reminder of the Alps in this expanse; only at length, the growth of the blue distance, the slow fall of the land on either hand, shows that we have reached the watershed, and stand on the Hohenlohe Plain. The true highland landscapes are here in reality below us, the rivers have force enough to cut ravines, though the atmospheric weathering merely flakes away the level strata, and forms no salient feature on the highland. This is, in consequence, a country of surprises, like the cañon-region of Arizona. Suddenly we may find ourselves dropped into one of the

unseen valleys; the road hurries down into a new and unsuspected world; forests climb the steep slopes round us, and bare rock juts out, in mountainous style, among the trees. The villages lose all their leisurely, unhampered, agricultural air, and become cramped in along the watercourses. Here again, if we have left regretfully the Black Forest or the Vosges, we hear with pleasure the rush of streamlets, and the disciplined thunder of the mills. The incident comes as a revelation, only too soon to be taken from us. We may well rub our eyes, when we have toiled up some winding ascent again, far above the timber houses and the red-tiled spires, and emerge upon the vast uniform plateau, across which the approaching night has thrown a veil of purple-grey and brown. Here the air is full of the scent of hay, blowing from the meadows, and making sweet the gathering dusk. The lights shine from scattered farms, each one a beacon in this featureless expanse; you can almost picture the Little People rising from the soft warm earth, whispering to one another, and wondering at a world of stars. One glowing band, raised slightly towards the sky, marks out some clustered city, still seven or eight miles away.

It is thus, perhaps, that we enter Rothenburg, the type of an old Bavarian town. The double gate, the central watch-tower, the narrow street of half-timber houses, take us back to the days of the Thirty Years' War, when the Swedes, like a north wind, swept the plateaux, and passed into the great plain of the Danube. The town stands on the edge of the Tauber valley, and looks across it to the farms and fields. The bridge leading from the west side lies far below, and is easily commanded from the wall; but on all the other sides the position lies open to attack. The structure of the great part of Bavaria has led to the formation of walled towns at every market-centre. In many cases, these are merely clusters of houses, intimately connected with the farmlands that lie beyond their gates. However, in a population brought together for mutual protection, division of labour soon arises, and the lower floors of many houses become turned into the shops of specialists. Other ground-floors to this day, even in Rothenburg, are used as stabling for the cattle; and at morning the cows are driven out through big barn doors from beneath the houses of the burghers, and are brought in again at evening within the protection of the walls. The whole history of this open country is typified in the story of its towns. The collective voice of what was once a settlement of agriculturists became in due course represented in the Rathhaus, where civic custom soon held sway; the craftsman, at first a necessary adjunct, became the critical purchaser and controller of the products of the farms; the great-grandsons of the men who dug the moat and built the ramparts learnt to carve the most exquisite panels on their house-fronts, and turned their proud and self-centred city into a sort of Gothic Florence. From the farrier and the maker of rude weapons sprang the men whose art in metal-work was destined for the table of an Emperor. Yet still, at every turn, the inflocking peasantry, the slow ox-wagons, the shop-windows full of scythes or apple-baskets, proclaim the absolute dependence of the city on the open plateau round it.

The smaller towns throughout Bavaria, which are often mere walled villages, are built upon so uniform a plan as to suggest a common ancestry. The high wall forms a rectangle, with a gateway in the centre of each of the shorter sides. Above these gates rise square towers, capped by conical red roofs. The houses are built with their backs close along the wall, so that the single street is in reality the market-square. The high road runs straight from gate to gate, but expands on either side into a great area, paved with rough stone setts.

The children play here after school-hours; the older women look for their husbands from the doorways as evening settles down; and then, seven or eight together, the men come through the mediæval gates, with scythes over their shoulders, or urging on the tired oxen. Surely this is the stereotype of the ancient laager of the plains, the old square formed by the wagons drawn up at each nightfall of the march; and within it the women and children are gathered, and the cattle are sheltered, and the next day's work is planned.

The old-world forest still covers a large part of the plateaux, and forms a welcome shelter from the cloudless midland sky. Ponds also abound upon the Keuper clays, and provide the peasantry with fish. A man will thus go outside the town-gate on your arrival, catch a weighty perch, and serve it forthwith for the mid-day dinner.

After a few days among the dusty grooves that are regarded as roadways in the forests, it is pleasant to drop down by one of the small streams to the Danube. The contrast provided by the valley-scenery is in itself refreshing. Green hill-sides set with white castles or monasteries; towns holding the passage, built across the roadway, and girt about with towers; a population no longer scattered, but gathered thickly along the one line of communication—all this makes one forget the monotonous upper plateau. At last we reach the foot of the Jurassic slope, and see the green Danube winding in its own alluvium.

Nothing could differ more in character than the two roads from Nuremberg to Kelheim, down the slope of the same geological formation. They divide at Neumarkt, and the one takes to the valley of the Sulza, joining the finer Altmühl river at Beilngries. Such towns as Berching, and other scenes unknown to Bædeker, conspire to give this route an air of high romance. The other road runs across the plateau, bare and uniform, until it drops into the ravine in which even the Danube runs at Kelheim.

South of the Danube, there is little material for gorge-cutting. The one exception is the fine cañon of the Inn upon the eastern frontier, between the water-gate of Scharding and the river-mouth at Passau; but here the rapid stream has cut down into the gneiss of the Bavarian Forest range, to join the Danube, which has become similarly entangled. The gneiss, which belongs structurally to the plateau of Bohemia, forms the north-east border of Bavaria, and was once submerged beneath the Cretaceous sea. Now, by the general Cainozoic uplift, it has become bared again, and forms a steep mountain range, on which the fir-woods gather.

As already hinted, the basin between the ancient gneiss and the Franconian Jura on the one hand, and the Alpine foothills on the other, has served as a gathering ground for all manner of detritus. Marine and lacustrine deposits were at one time common on it;* but these older Cainozoic beds were formed before the Alps began to rise, and when the basin was wider and more open. They became folded into the Alpine foothills on the south, and were soon covered in the lowlands by the alluvium of the Alpine streams. In the great

* C. W. Gümbel, "Geognostische Beschreibung des bayerischen Alpengebirges" (1861), pp. 756 and 770.

days of denudation, when the Alps were at their height, enormous quantities of pebbles were brought down; one fan of *débris* spread across another; the frequent flooding threw several rivers into one; and the whole lowland became invaded by a vast detrital cone. On the slope of this inland delta, the rivers still run down in force; but they are now carving out shallow valleys in their old accumulations, and are exposing the Miocene beds below. Floods, such as those of 1899, tend, however, to restore matters, and the whole country between the Danube and the Alps is in a state of flux, and gives us an amazing picture of the decay of continental barriers.† The growth of the delta has forced the Danube up against the hard rocks to the north, and is probably responsible for the ravine of Kelheim in the Jurassic limestone, as well as for that in the gneiss from Vilshofen to Passau. Regensburg lies at the most northerly extension of the cone, 140 kilometres from the source of its material in the Alps.

The great southern tributaries of the Danube run north-easterly, eroding, as M. Reclus‡ points out, their right or eastern banks; this is attributed to the earth's rotation, which affects these moving bodies of water equally with the winds. The result has been a steady shortening of their tributaries on the east, and a steady elongation of those entering from the west. It is, however, noteworthy that the north-easterly trend does not set in until the coarse deposits near the Alpine chain have been left behind;§ the resisting character of these relics of glacial times has probably allowed the general northward slope, modified by any local irregularities, to play the most important part in directing the courses of the streams.

The glacial beds in Upper Bavaria often consist of tough conglomerates, which at one time choked the valleys, just as they did in the gorges of the Alps above Trieste. The rivers, attacking these beds with youthful vigour, before their entry on the plains, have cleared out their courses again through them, showing fine sections on the vertical walls of the ravines. The frontier-road from Neu-Otting to Salzburg runs on a plateau of these deposits, and the River Salzach for the most part is seen far below in its ravine. At Burghausen, which is set low down to guard a bridge, the castle is built on the face of the cliff itself, and the single street is narrowed almost to a foot-path, with one line of houses between it and the swift green water. A period of excavation has evidently again set in, as is the case in so many of the choked valleys in our own islands. The rivers in old days must have been more rapid, flowing from yet higher hills; but the very intensity of denudation along the crests supplied them with too much material. Nowadays, the clearer, if slower, water is removing the obstruction and is gradually restoring the topography of the mountain-slopes, much as they were at the close of Pliocene times.

As is the case in so many areas of deposition, a sinking of the floor of Bavaria can be proved to have taken place between the northern plateaux and the Alps. The edge of the Bavarian forest, where the contrast of the alluvium and the crystalline rock is so conspicuous, is, according to Prof. Suess, a line of differential movement. The Bohemian highland, with its forest-rim, thus owes some of its eminence to the sinking of adjacent land. It is thus that great receptive basins continue to be available for the successive accumulations that come down; at the same time, the highlands that supply the pebbles, the sands, or the clays, escape being entirely banked up and covered over by the products of their own destruction. Gümbel‖ believed that the finer material covering the glacial beds in southern Bavaria was deposited in a lake, formed as the Alps themselves sank, and thereby altered the curvature of their northern slopes. Prof. Heim has urged the same subsidence of the central chain to account for the sinuous lakes, which are clearly flooded valleys, on either side of the Alps in Switzerland. From this point of view, the curious lakes, the Chiem See and others, with their low and often boggy shores, now found in the southern plain, are relics of a vast sheet of water which spread down to Munich in recent geological times.

The Alps form a natural boundary to Bavaria on the south; but the watershed, along which the metamorphic rocks crop out, falls within Austrian territory. Consequently, as Reclus has remarked, Bavaria does not possess the sources of any of her larger rivers. The Isar, for example, rises on the back of the wonderful rock-wall above Innsbruck; but a good part of its course through the forests of the highland is none the less effected in Bavarian territory. The Inn, however, has performed all the grand part of its journey, in a valley almost unsurpassed in Europe, before it emerges on Bavaria, where it only adds in flood-time to the wreck and desolation of the plain. It recovers, as we have seen, some trace of its former grandeur when it encounters the northern crystalline rocks near Passau.

Such of the Alpine foothills as fall within Bavaria repeat the features of the Bavarian Forest, though with more variety of scarp and slope, owing to their being formed of stratified materials. Fir-woods clothe them for the most part, and it is strange to pass from these gloomy uplands to the vast fan-taluses known as the Bavarian plain. It is thus in the extreme south, or again in the north-east, on the bold descent to the Danube from the forests of Bohemia, that we may best realise the charm of Bavaria as a land of fascinating contrasts.

† Compare "The Heart of a Continent," KNOWLEDGE, Vol. XX. (1897), p. 284.

‡ "Géographie Universelle," tome III.

§ *See* Lepsius's "Geol. Karte des Deutschen Reichs," sect. 27.

‖ *Op. cit.*, pp. 852 and 872.

MODERN PISCICULTURE.

BEING A DESCRIPTION OF THE SOLWAY FISHERY.

By T. A. GERALD STRICKLAND.

THE interesting and most useful pursuit of artificial propagation of fish is no *fin-de-siècle* discovery. The Chinese have practised it from time immemorial down to the present day. A quite modern traveller, C. F. Gordon Cumming, says:—"I inspected some artificial fish-tanks, the lowest of which is periodically drained by means of an endless chain of buckets worked by a treadmill."* The Romans also went in rather extensively for fish ponds, and spent large amounts on them, indeed the ponds of Lucullus are said to have cost a sum of about £30,000 in our money. The Roman system was very simple compared with modern fish culture, for "it appears to have consisted rather in conveying the spawn of fish from the spawning bed to an exhausted lake, and thus replenishing the waters, than actually ejecting the ova and impregnating them with milt by an artificial process."† In the middle

* "Wanderings in China," by C. F. Gordon Cumming.

† Dr. E. Percival Wright in "Animal Life."

ages the monks kept ponds of carp in preparation for their fast days, and Jacobi, who wrote an elaborate treatise on the subject, brought the art down to our own time.

When in Scotland last autumn I had the opportunity of examining at leisure a large modern fish farm, the Solway Fishery, and it is this that I am about to describe.

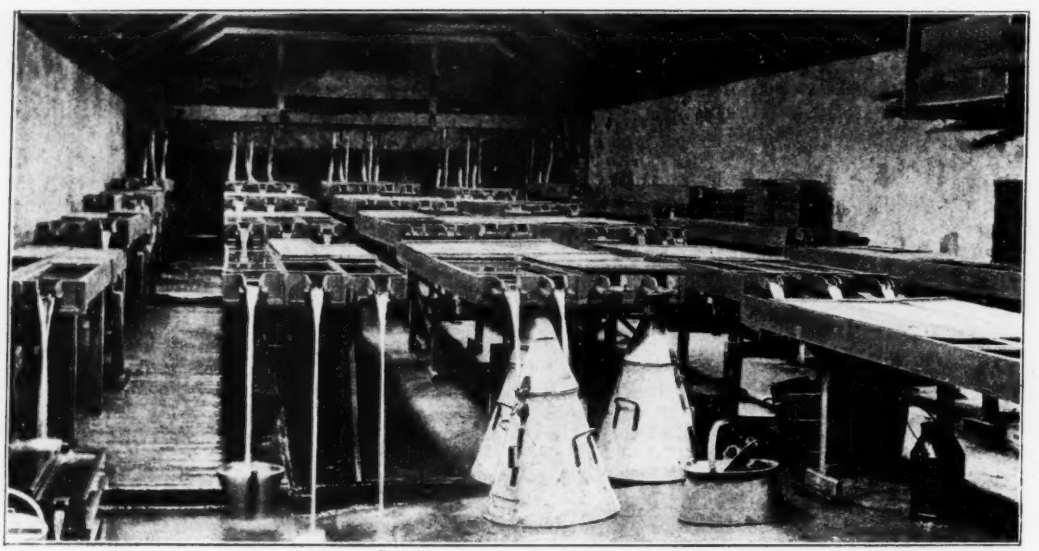
Most of the quotations appearing in this article, the sources of which are not stated, are from "An Angler's Paradise," by Mr. J. J. Armistead, who, some nineteen years ago, started the fish farm on its present site.

The fishery, which is situated in a beautiful valley, surrounded by heather-clad hills and grouse moors, is sheltered from gales by extensive fir woods, and, what is naturally of the greatest importance in an undertaking of this sort, is copiously and unfailingly watered by the Pow and Tannox burns. The source of the latter arises on the mountain Criffel, which stands like a grim sentinel in the background. The grounds of the fish farm, which comprise many acres, are divided into various sized ponds, connected by "raceways," through which water is always flowing.

Each pond is inhabited by fish either of different species or of varying ages. For instance, one pond has 800 specially selected British two-year old trout, another from 2,000 to 3,000 large Rainbow (Salmo irideus) and American trout (S. fontinalis), and others are the homes of innumerable fry, two-year old salmon (S. salar), dace, bream, roach, perch and other fish. One stagnant pond is inhabited by carp, and there is also a pond of stickleback in which the greater duckweed flourishes. There is never any scarcity of water as, besides the two streams already mentioned, there are splendid springs; but the water from these is unsuitable for fish until its character is entirely altered by flowing through raceways which are inhabited by various aquatic plants and mollusks.

The fry ponds are about 60 feet long by 4 feet broad, and those that contain the adult fish are about the same length but from 9 to 10 feet broad. The newer ponds, now in course of construction, are lined with concrete, and so are easier to keep clean. At the end of each pond is a perforated zinc plate that allows the water to flow through but keeps the fish prisoners. This has to be scrubbed every evening to keep clean and free from weeds, as, the water supply being natural, in the event of a heavy storm, there would be a rush of water which, if the outlets were insufficient, would flood the ponds mixing all species and sizes of stock together! This, as may be imagined, would be fatal for more reasons than one, for Shakespear was quite correct in stating that "fishes live in the sea—as men do a-land; the great ones eat up the little ones."‡

Yes, all fish of the same size and age have to be kept in separate ponds, as trout are great cannibals; yearlings eating fry, three year olds devouring yearlings, and so on. The stock fish, when allowed to spawn naturally, have been seen eating their own ova! When the fry have become yearlings "it is found necessary to take them out of the pond and sort them. If this be not done the larger fish will eat many of the smaller ones, and at the end of two or three years their sizes would be altogether disproportioned, some weighing two or three ounces, others as many pounds. I have known cases of trout (Salmo fario and S. levenensis) reaching the weight of four pounds in two years, whereas it usually takes three years for a trout to reach a pound."§



HATCHERY AT THE SOLWAY FISHERY. (*Photo by* W. ANDERSON.)

The process of modern fish culture is briefly as follows:—Trout and salmon are the only fish, as a rule, artificially spawned and hatched, the so-called coarse fish being allowed to make their own family arrangements in the ponds. For instance, perch spawn naturally on weeds.

Salmon are generally disposed of in the "eyed ova" stage, as, being anadromous, they will not come to perfection if kept entirely in fresh water. According to

‡ Pericles," II., 1.

§ "Atmospheric and other Influences on the Migration of Fishes," by J. J. Armistead.

Isaak Walton, "The Salmon (Salmo salar) is the king of freshwater fish, and he has, like some persons of honour and riches, which have both their Summer and Winter residences, the fresh rivers for Summer and salt water for Winter to spend his life in."

We must conclude then that it is a case of "uneasy lies the head that wears a crown," because a more modern authority (Frank Buckland) remarked in a lecture, "perhaps the most unfortunate thing in the world is the salmon. Everybody and everything, from the otter to the fisherman, persecutes him." Again, "the trout then comes to eat the eggs, next a whole swarm of flies and insects; then the water-ouzel, who goes to eat the flies, is shot by ourselves under the idea that the bird is after the eggs, and not after the flies; the result is that not one egg out of ten thousand ever becomes food for man."‖ So, though fish culturists cannot keep the salmon till they arrive at maturity, artificial spawning and hatching obviates these initial evils, and, so to say, gives the young salmon a fair start in life.

The spawning season of trout is from October to January inclusive, and they begin to spawn when about three years old. The stock fish are examined from time to time by an expert, who can tell at a glance if they are ripe for spawning. An expert can also distinguish the males from the females easily, as a rule, which would not be a simple matter for an ordinary observer to determine.

When the fish are ready to spawn they are netted from the stock ponds, and the finest selected are removed to the spawning shed in large two-handled tubs. The female fish are placed in a large trough with divisions, and the males in a large tub. Two or three females are removed from one of the divisions of the trough in a landing net, which is then held over a carefully dried basin and the ova gently squeezed (stripped) from the fish into the receptacle. The fish are then returned to the trough but are placed in an empty division. When the basin is considered to contain enough ova, a male is netted from the tub, held over the basin, and his milt squeezed on to the ova.

The spawn and milt are then gently stirred together, when they adhere for a short time and then again become separate. When this occurs the ova are well washed and placed on "grilles." These grilles are shallow trays with wooden sides and glass bottoms made of glass rods placed side by side, which keep the eggs from washing away, but allow the water to flow over and through. Each grille, which holds from 3,000 to 4,000 eggs, is then removed to the hatchery. The hatchery is one of the most interesting buildings on the farm, and the photograph conveys a good idea of its internal appearance when in full work. The water is laid on through underground pipes so that the supply shall never freeze in transit, and the hatchery itself is heated with hot-water pipes, as before this was done, the supply of water on arrival sometimes froze and consequently might have ceased flowing through the hatchery boxes had not an attendant remained present all night in order to prevent such a contingency. The hatchery boxes containing the grilles must have a constant stream of water running through them. These boxes are provided with removable covers, as the process of hatching has to take place in the dark. When the alevins appear a part of the cover is removed so that the fish can be in light or dark surroundings as they prefer. Spawn takes about three months to hatch according to temperature.

The ova are forwarded to all parts of the world when they are "eyed," which occurs from 50 to 60 days after spawning. The packing of the ova is a very important matter and the eggs are never touched by hand. Wooden trays are constructed with bottoms of well-seasoned perforated zinc. On the zinc is laid a sheet of felted moss (a suitable moss is cultivated for the purpose), and over that a piece of fine net is placed, then a layer of eggs, then more fabric, more felt, fabric, eggs, and so on. Each tray holds three layers of eggs, and eight trays are placed in an inner case which is packed round with sawdust. For sea voyages of long duration an extra tray with perforated bottom is filled with ice and put on top of the inner case; this lowers the temperature sufficiently to retard completion of hatching till arrival at the destination. Sometimes, for very long journeys, the eggs are packed simply between moss felt without intervening fabric.

Rivers and lakes in Australia, the Cape, New Zealand, Canada, etc., have been stocked with fish from this farm, and have done well, so evidently the eggs travel satisfactorily in this way. Only spawn is sent abroad, but fish, from the fry stage to adult, are sent all over Great Britain and Ireland for stocking rivers and lakes. The fry are retained in the hatching boxes for six weeks after emerging, and they require no food for the first month, as they have an umbilical sac, on the contents of which they live till their mouths are in a sufficiently developed state to take external sustenance; for the alevins on first leaving the egg, though more finished in appearance than the wormlike offspring of the kangaroo, are by no means the "speckled beauties" they become eventually. After six weeks or so the fry are removed to small fry or nursery ponds. The adult fish are fed twice a day and the fry four times; their food consists of horseflesh, beef, etc., which is passed through mincing machines. The best food of all is said to be shrimps, but these, though the company keeps a private trawler for the purpose, are not always procurable; other foods are also largely used, and one of them is maggots. There is a large maggot "factory," where all meaty scraps, offal and dead vermin are collected and quickly turn into an appetizing (?) nutritive food. The meat is suspended on an iron grating, and the grubs, as they appear, fall through into a tray and are swept up, meal fed, scalded and divided among the ponds. Tadpoles are also used in immense quantities, and frog spawn is procured literally by the ton every season to breed from. Crustaceans, mollusks, insects, etc., are also of great benefit, but these I will return to later. The food of the adult fish is thrown on the surface of the ponds. It is a curious sight to see the fish fed; one moment, you look on an unruffled sheet of water reflecting the trees and clouds as a mirror; the next, an attendant having thrown a handful of mince in, the pond suddenly becomes a rough sea, and some of the inmates leap right out of the water in the exuberance of their spirits, their sleek, spotted sides glistening in the sun. The fry are too small to swallow the ordinary minced meat, so they are fed in a different manner. An instrument called a feeder is used. It is a box about 9 inches square and 4 inches deep, made with wooden sides, a perforated zinc bottom, and a long handle. A little food is put in this box, which is then half immersed in the water of the fry pond and moved from side to side. The smaller particles of food gravitate through

‖ "Life of Frank Buckland," by G. C. Bompas.

XUM

the perforated bottom, and the thousands of fry which can be seen feeding form a pretty sight. The large pieces left in the feeder are given to the adults.

The fish are sent all over the country in specially designed cans, externally not unlike milk cans. In the packing room the fish are placed temporarily in tanks, sorted as to size and age, and then put into the travelling cans which are three parts filled with water. The cans have false tops, which form receptacles for ice. The jolting of the train or vehicle keeps the water splashing against the perforated bottom of the false lid filled with ice, which effectually cools and oxygenates it. The fish are not fed for some time before starting on a journey, so as to prevent them fouling the water, and they evidently do not mind shaking, as "in some cases fish have been carried miles over rough and trackless mountains in carriers specially made, which are fitted with wooden handles, by means of which two men can carry each over the roughest ground, hauling them up the face of the steep rocks and floating them across streams. Where mountain ponies can be used we can send carriers that can be slung pannier fashion across their backs."¶

Large fish on arriving at their destination are dipped in salt water before turning out into their new abode. This immersion in salt water seems to be the great cure for the dreaded fungus (Saprolegnia ferax) and the various parasites fish are so subject to. The yearling stage seems to be the most satisfactory for stocking waters, though fry have turned out extremely well, too, and, of course, are very much cheaper.

I must not bring this article to a close without mentioning the ponds of various beautiful aquatic plants. Some plants and fish seem to have formed a kind of mutual benefit society, the former "consuming carbon and returning oxygen," and the latter "consuming oxygen and returning carbon." Of course certain species of plants are more beneficial than others; for instance, some, besides producing oxygen, form perfect strongholds, or colonies of the much-to-be desired members of the crustacea and mollusca that suit, and indeed are so necessary to, the fish.

Interesting experiments in acclimatization are carried out on aquatic plants from all parts of the world; Japan and India supplying their quota. Besides those plants that are grown from a strictly utilitarian point of view are others that, if not of much use as food producers, are at all events harmless to fish and cultivated for their magnificent foliage and beautiful flowers.

¶ The Company's Catalogue.

THE EVOLUTION OF SIMPLE SOCIETIES.

By Professor ALFRED C. HADDON, M.A., SC.D., F.R.S.

III.—THE PASTORAL SOCIETIES.

IN my last article I dealt with the Kalkas, as illustrating a simple and homogeneous human society. I now propose to take a general survey of three main types of the pastoral mode of existence. In doing so I follow in the steps of M. E. Demolins ("La Science Sociale," XV., p. 173, etc.). The selected types are the following:—

1. The type of the Steppes.
2. The type of the Tundras.
3. The type of the Deserts.

These three groups agree in the intense development of the family community, and the absence of higher social organisations, but they differ in the organisation and extent of the community of the family.

In the Steppes the family community attains its highest degree of purity and intensity. We have already seen how the steppes produce abundant grass on which large flocks can be supported, and how the family communities find in the pastoral life sufficiently complete resources. They are not obliged to have recourse to accessory industries, being so self-contained the communitary influences of the pastoral art are scarcely influenced from the outside. Nowhere do communities attain a higher degree of independence, nowhere is paternal authority so powerful or uncontested. The father is in very deed magistrate, priest, and king.

In the Tundras a marked weakening of the family community is observable. Here grass is scarce and of poor quality, and its place in the far north is taken by the lichen known as "reindeer moss." The herders of reindeer in this inhospitable circumpolar region, the Lapps of Norway, the Samoyads of Siberia, and the Eskimo of North America are well known, and of these the Samoyad is the least changed. Life cannot be maintained, as further south, by the pastoral art alone, and so recourse must be had to fishing and hunting. The reindeer are well broken in and trained, and have reached a high excellence as draught beasts. The sledge, too, is perfectly adapted to the physical difficulties presented by the tundra. The reindeer is a veritable "staff of life"; its skin makes the tent, and constitutes the chief material for clothing. Its body is the main food for the Samoyad, and its hide and sinews are made into harness, cordage, and thread. It is the only animal which is fitted to draw burdens across the tundra, a quaking bog in summer, a howling frozen plain in winter. In the latter season the Samoyad hunts, attacks and snares the white bear, brown bear, sable, fox, lynx and other fur-bearing animals; in summer he catches enormous numbers of birds, geese, swans, duck, etc. Parties of Samoyads bring furs to the markets across the tundra, before the melting of the snow makes it impossible for him to take heavy loads across the tundra; those who remain behind complete the season's harvest; these are rejoined by the trading parties before the rivers burst free from ice, and the whole country becomes an impassable swamp. But the two occupations of fishing and hunting, which require agility and strength, tend to augment the importance of the young to the decrease of the influence of the old, that is to say, of the natural chiefs of the community.

In the tropical deserts of North Africa and Western Asia the pastoral art is insufficient to support the population. The insufficiency in this case is due to extreme heat and drought, which only admit of sparse and poor grass. Hence the camel is the dominant animal in that zone where this social type is most characteristic.

It is necessary to have recourse to supplementary resources. These resources are indicated by each particular locality; but the main features are similar, since these deserts lie between the tropics with their rich productions, and the southern temperate region, with a population enriched by cultivation. The pastor of the desert will go to one or other confine to procure the necessary supplement to his means of subsistence, which he exchanges for various fabrics for which his flock furnishes the raw material, and which are manufactured by his family. This mode of life was early developed into an organised system of trade, thus the patriarch of the desert naturally becomes the leader of a caravan,

and acts as a middleman between the civilizations of the Mediterranean and the savage tribes of Central Africa on the one hand, and the civilizations of the Orient on the other.

This simple difference in the conditions of life imposes a grave transformation on the family community. Each year very long journeys have to be made from the interior of the desert to its borders in order to exchange merchandise. Other communities, also on the march, are met with, and dispute pasturages and wells, as these are few in number and limited in extent. The merchandise must always be protected, hence the trading parties must be as numerous as possible, and have experienced chiefs—the most experienced possible, it is a matter of life and death.

This necessity constrains the development of the family community. When a community is too numerous in the prairies a portion separates under a new patriarch, usually one of the brothers of the old one. Here a community is never too large. They do not separate into family groups, but remain together and become a *tribe*.

The tribe contains several hundreds, sometimes several thousands of persons. In order that such multitudes may exist on so poor a soil they are divided into small groups or "douars," which are like the companies of a regiment. But all these groups, who follow one another on the march, form only a single community under the direction of one chief, and are always ready to rally at the first signal and at the least danger.

In this way the family community has extended to the proportions of the tribe. It is the first complication; but it induces another which is yet more characteristic.

This grouping permits, even necessitates, the elevation of certain specialists in the midst of the group, thus appear the special ministers of religion such as the well-known marabout arab. The marabout is at the same time a specialist in intellectual culture, and to him is given the teaching of the children. Thus two functions are withdrawn from the father, those of religion and teaching, it is a first and grave diminution of the patriarchal attributes.

But this is not all: the direction of affairs is also taken away from the heads of the families; they are constrained on the one hand by the council of the tribe which is composed of the most notable patriarchs, and on the other by the chief of the tribe. It is necessary for the chief to be armed with great authority, for he must defend and protect not only the public interests but also those of private life; he not only organises attack and defence, but he also regulates the watering and commonage of the flocks, and indicates the pasturage: he is thus the patron of labour.

The attributes of the patriarch are very sensibly diminished, nevertheless the type still belongs to the societies of the simple communitary formation of the family, for the tribe is only an enlarged patriarchal family.

These three types differ in their aptitude for dispersal, and in the influence they have exerted on neighbouring peoples. The pastors of the steppes are apt to swarm, but are not qualified to organise invasion or to remain masters of the conquered country. The pastors of the tundras are not liable to expand, also there is no question of their organising invasions or of conquering other peoples. The pastors of the deserts are notoriously apt to spread, to organise invasion and to remain masters of the conquered countries.

The aptitude of the *Pastors of the Prairies* to spread is naturally explained: they are nomads and consequently accustomed to shift their quarters; in order to invade they have only to march in a straight line towards a definite point instead of wandering here and there on the steppes; they have scarcely to change their ordinary life. Further they possess the horse, which is an incomparable means for transport. The problem of the commissariat, so important and difficult in a military expedition, is spontaneously solved, their food—*i.e.*, their flocks—marches with them.

So far good, but here commences the difficulty, the population of this type are not good at organization. These societies are formed of absolutely independent families. No superior organization exists above the simple patriarchal family. At certain times a number of people from different families may associate in a more general group, as, for example, to go on a pilgrimage to some distant lamasery, but these caravans are purely accidental and the power of the chiefs of the caravan ceases as soon as the caravan reaches its goal.

In these societies of small autonomous groups, without constituted government, and subject to a centrifugal force, all collective action is very difficult. To produce it, to blaze out into an invasion, it needs a rare combination of favourable circumstances, which renders one man prominent, some chief of a caravan, for example, able and celebrated, fit to lead these masses which are without cohesion.

It is precisely because this combination of circumstances is so exceptional that these populations overflow their natural boundaries only at very rare intervals. But then the invasion is the more formidable, and such are the innumerable throngs who precipitate themselves in the wake of an Attila, of a Jenghiz-Khan, of a Tamerlane.

These very names suggest the idea of unorganised multitudes, rushing like a torrent, but not advancing like an army. The original inaptitude of the type for any large grouping, for any complicated organisation, and for surpassing the narrow limits of the patriarchal community, is manifestly brought to light.

For a very good reason these invaders are precluded from organising and administrating the conquered peoples; how could they bring to them the social elements, the organization of public life which they themselves lack? Thus is explained the state of anarchy and the rapid disappearance of the empires of Attila, of Jenghiz-Khan, and of Tamerlane; they traversed history like a flash of lightning which rends a cloud and immediately disappears into obscurity.

The Pastors of the Tundras are still less favoured. They have not even the first requisite for invasion, the means of transport. They only possess the reindeer, the dog, the sledge, and skates. With these it is impossible to go beyond the limits of the Boreal region. It is a serious difficulty to enter into a campaign. In these icy regions it is absolutely impossible to agglomerate a large number of men and animals on account of the scarcity of pasturage, and large areas are necessary for even a small herd of reindeer.

Never has history recorded, nor will it ever record, a single invasion by Eskimo or Lapps.

With the Pastors of the Deserts we meet with a type, the most capable not only to swarm but to organise invasion, and to remain master of the conquered country.

As means of transport they have the camel and the Arab horse. The nomad life renders these people even

XUM

more facile for movement than the pastors of the steppes, as the poverty of the pasturages necessitates the frequent shifting of their abode. No nomad surpasses the Arab in celerity of movement.

Thanks to the habitual life of the caravan, for the tribe is only a permanent caravan, this type possesses the complete framework of an army. It is an army always on the march, always in exercise, always ready to shift the camp, with a council of chiefs and a commander-in-chief. And the army is as well prepared for attack as for defence, for life in the deserts is a continual struggle against inimical tribes. When a favourable occasion offers to expansion the tribe affords an effective organization, ready at a moment's notice, with a proved chief, who knows his men, and is known by them.

This type is also very superior to that of the steppes from the point of view of administrating the conquered country.

No one can ignore that the empire of the Arabs has played a very different part in history from that of Attila and Tamerlane. There has been an Arab civilisation and it was brilliant; the justice and the administration of the Caliphs are celebrated, and justly so. They knew how to rule not only the Orient but Spain, they knew how to develop not only culture but the arts, letters, and the sciences. For there was an Arab art and science. No one has ever heard of an art or science of the Tatars or of the Mongols.

The aptitude for government is equally the result of the permanent organisation into tribes. As tribes, these societies possess the machinery for government under those conditions which assure permanence and solidity. In this, the Arab society approaches the complicated societies of the west. The tribe is a natural and permanent grouping which does not tend to dissolve after victory. The necessity to annually sell the products of fabrication puts the Arabs also into relation with town life.

There are certain characteristics that are common to the peoples under review. There is:—

(1) Community in occupation. The nomad pastoral art requires a numerous staff (*a*) to herd and make use of the flocks that are necessarily spread over considerable areas; (*b*) to defend themselves and their flocks, for they can have no other security in these solitudes; (*c*) to counteract the tedium of isolation, and to meet the adventures of a wandering life; (*d*) to provide for the numerous articles of domestic use, for most usually each group has to be completely self-sufficing owing to the distance it is from all the resources of commerce.

(2) Community in property. Grass grows without the labour of man hence there is no work expended, which of itself tends to create a proprietary right. The soil is unappropriated by individuals or even by family groups for the nomad population. Extensive commonage is more useful than the exclusive possession of a restricted definite area.

(3) Community in the family. Since a pastoral life demands a numerous staff, the various households derived from a common ancestor tend to remain together under the rule of the community, instead of separating to establish themselves independently. The girls naturally separate, but only to enter into another community, into that of their husbands. Such is the type of the patriarchal family which groups a large number of households around each chief or patriarch.

What characterises this group of societies is not only the intense development of the community, but also *the absence of all higher social organisations.*

These societies are entirely limited to the community of the family, it is precisely this which gives to all this group of societies its great character of simplicity. None of the complications which result from the higher organisations of social life, or of public life, can be produced here, since these organisations do not exist. Or, at least, they only exist latent, so to speak, in the state; they are not separated from the family, they are blended with it.

It is in fact, the chief of the community who fulfils, according to circumstances, the diverse functions, which elsewhere are specialised, of patron, teacher, religious instructor, policeman, magistrate, sovereign. These functions appear here as the attributes and extension of the paternal authority.

In a word, each community is in itself a little, complete, autonomous state; it is a social microcosm.

Two principal effects are produced by the communitary organisation:—

1. *Aversion to Hard Work.*—It is evident that people who live under the *régime* of the community, who draw upon the common estate, not in proportion to their labour, but in proportion to their needs, are naturally inclined to work as little as possible; each has a tendency to rely on the labour of others much more than upon his own, and as a consequence is tempted to make the least effort.

The indolence, passiveness, fatalism, which characterise the pastoral peoples, or those derived from pastors, appear to owe their origin to the communitary organisation.

2. *The Minimising of Individual Initiative.*—Men who are born, who live, and who die in a community; who during their whole life have no need to take a personal decision, nor to incur any responsibility; who in everything have to submit to the authority of the chief of the community; who cannot do anything without the sanction of this community; men, in a word, who are perpetually considered as minors, can have no initiative. How can they have even the conception of it? One sees here the cause which has so profoundly developed the principle of authority in the East, and which has made the patriarchal power the highest expression of this authority.

The absence of hard work and of initiative is very slightly inconvenient in pastoral societies, where the problem of life is greatly simplified.

Man is not naturally inclined to work: the grass, which is the principal resource of the herders, requires no labour, it renews itself each year. The soil upon which he pastures his flocks cannot be lost to him, for it belongs to everyone. Each enjoys it in perpetuity, despite his improvidence and comparative laziness. This happy proprietor has no dread of mortgage, of usury, nor of dispossession.

Mankind is by Nature little inclined to initiative. The pastoral art is, by its nature, immobile; it is not susceptible of improvements, the pastor has only to do tranquilly what has been done since time immemorial by his predecessors; he may act by routine at his ease, without compromising his interests.

THE ROYAL ACADEMY EXHIBITION.

The labour bestowed by the Royal Academy of Arts in selecting works for its annual exhibition is enormous, while the efforts made to deal justly and generously with the multitude of artists and others who send in

works for acceptance, are such as can only be bestowed by a highly trained and a high-minded body of men.

Works in sculpture, oil and water colour, black and white, and architectural designs, pour into the cellars of Burlington House during the three days granted to would-be exhibitors until they total some 14,000. The names and addresses of the authors of each work have to be recorded, and the thousands of pictures, or framed works, have to be sorted and arranged, more or less according to size, in order that they may be viewed.

When the viewing day comes, a council of ten Members of the Academy sit and see the whole of these works. It is obvious that men of the highest standard in their art, trained in eye and mind, are able to reckon up the relative merits of very many of the works brought before them in a moment. A Council of Examiners conducting a *vive voce* examination on some hundreds of students, seeking to pass in French, would dispose in an instant of such as could not speak three words of that language. Thus fall some thousands of works, which their authors and friends esteemed highly, no doubt on the principle "Where ignorance is bliss 'tis folly to be wise." Tolerable works receive more attention, but the greater number of these follow the multitude downstairs into the cellars. Anything that the eagle-eyed Council regard as good work is set aside as doubtful (that is, accepted to be hung if space permits), and these works are so numerous that it is utterly impossible for anything like the whole of them to obtain a place upon the walls. A very small quantity of exceptionally good works—seldom more than eighty—are "accepted" to be "placed" in excellent positions.

The labour of viewing some 14,000 works is enormous. A procession of bearers carry the pictures in a stream before the Council, the names of the various artists not being mentioned. Sometimes the stream rolls on, dull and heavy, at other times it sparkles with "good things." Woe to the mediocre work that finds itself amongst the pearls; had it appeared in the midst of the dull and heavy it might have had a chance, but in all things comparisons, if odious, tell. A very small part of a second can be given to the larger number of the works, as here described.

A vast number of the works have now to return to the cellars. As the works leave the large gallery, where the Council sit, they are classified at once by a staff of commissioners stationed in the various galleries, and are thus alphabetically registered. Some thousands of cards are issued to the authors of these works, the educational effect of which should be to make each recipient "A sadder but a wiser man."

The first part of the Council's labour is now over, and so great is the strain of the concentrated attention given to the work, that most of its members are exhausted. This portion takes from seven to eight days.

Then there comes a selection of the selected works—a second viewing. The "doubtfuls" are far too numerous for the space yielded by the walls of the Academy, and hence this fresh sifting.

The duty of the Hanging Committee, consisting of five Members, now begins.

The Academicians, whose works have been passed in outside the turmoil of the 14,000, have first to be considered. This year the Academicians are particularly strong, and their works are, as a whole, such as have not been seen for many years. Each Academician is entitled to have four only of his pictures upon "the line," a graceful act to the outside artists, who otherwise would hardly ever obtain this desired position. Places of honour are apportioned to the finest works of Members, and after that, places of honour and position are given to the "accepted" works, and the best of the doubtfuls.

The mass that is left is picked over for the remaining space. The sizes of pictures tell for or against their being hung, as also does the subject, and the colour of the work. Let anyone sit down in a room of the Exhibition and observe how well balanced in size, subject, and colour, most of the walls are, and consider the labour of the Hanging Committee.

No Member of the Council (with the exception of the President and Keeper) is allowed in the Galleries until the hanging is complete. Then the other half of the Council, together with the President and Keeper, go through the rooms. They pass the work of the Hanging Committee, should it be approved, but it very often happens that what is considered an injustice in the hanging of a picture is at this final viewing altered by the Council.

But the labour is not yet over. First and foremost, the endeavour of the Hanging Committee has been to give as good a show as is possible; still errors may have crept in. Has any "accepted" picture, with its red star, been overlooked? Has an old exhibitor who once earned fame for himself been lost sight of? If such is the case, the Committee orders such works to be hung, and down must come other works to make room. No alteration can take place after this.

Everything that can be done to act justly and generously has been done, but there are hundreds of "doubtfuls" for which no place can be found, and some, no doubt, are better than works that are hung. Perhaps these did not fit, perhaps they were overlooked. Also, as it is impossible to satisfy everyone whose work finds a place in the Exhibition, there must always be a considerable amount of annoyance caused to exhibitors whose work is poorly located.

The Royal Academy of Arts holds itself highly. On the Press day none of its Members appear. The critics are left severely alone to say their worst or best. The critic who finds fault is less likely to be laughed at for his ignorance than he who falls into the error of lauding an inferior piece of work.

ARTIFICIAL "RESEAU PHOTOSPHERIQUE."

By the Rev. ARTHUR EAST.

EVERY student of solar physics is acquainted with Sir W. Huggins' drawing of solar granules which is given in all the text books. Since that drawing was made, some thirty years ago, we have had the magnificent photographs of Mons. Janssen taken at Meudon, showing with marvellous detail the granulation of the solar surface, and exhibiting somewhat the same rectilinear arrangement of certain portions of the photosphere, which Mons. Janssen has named the "reseau photospherique." So far no explanation has been given for the disposition shown in Sir W. Huggins' drawing, so that failing a better the following is offered, derived chiefly from a study of artificial granules—that we have here a beautiful demonstration of the exchange we know must always be going on, by means of vertical currents between the upper and lower levels of the photosphere. Masses of the heated lowest strata must of necessity

rise, become relatively cool, travel hither and thither over the upper surface, so far as other heated masses also striving equally to extend themselves will allow, and sink again to make room for others, and rise again

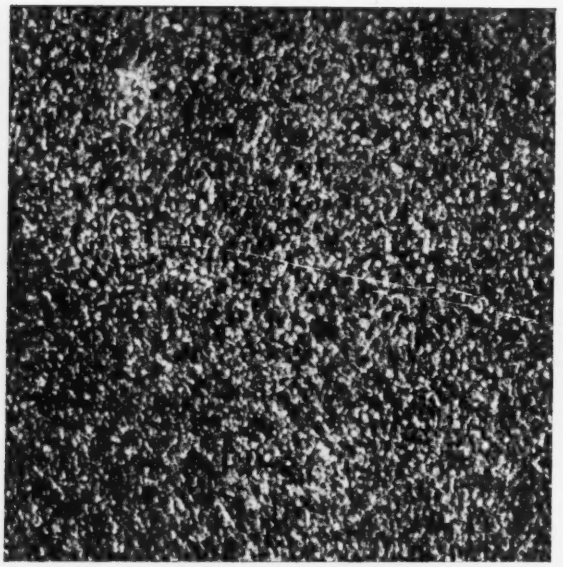


Fig. 1.—Photograph of the Sun's Surface, showing granule pattern.

in an endless series. And to these larger masses applies no doubt M. Janssen's remark as to, what he names, the "éléments granulaires."

"On sent que la sphère a été la forme première des éléments, ces éléments sont constitués par une matière très mobile qui cède avec facilité aux actions extérieures."

That is to say, the rising masses of heated photospheric material are normally spherical, and the rectilinear arrangement forming the "reseau" is the result of the mutual pressure of the masses.

An attempt has been made to reproduce these reticulations by the artificial method previously given in KNOWLEDGE, and some examples are presented in the accompanying illustrations, together with two reproductions of the Meudon photographs. The method consists in floating granules of the curd of milk in a saturated solution of salt and water, and putting the pan containing the solution on a hot plate; almost immediately spherical or at least round-headed masses of the granules begin to rise, and when these masses meet they mutually compress one another, the lines of impact being mostly straight: thus we get a very regular "reseau," with this remarkable piece of information that the lines of separation between the areas are formed exclusively by descending granules, the middle of the reticulations being the area of ascending granules. Let me quote again M. Janssen's description of his "reseau."

"Un examen attentif des photographies montre que la surface de la photosphère n'a pas une constitution uniforme dans toutes ses parties, mais qu'elle se divise en une série de figures plus ou moins distantes les unes des autres, et présentant une constitution particulière.

"Ces figures ont des contours plus ou moins arondis, souvent rectilignes, et rappelant le plus ordinairement des polygones."

These polygons are a very distinct feature in the artificially produced "reseau photospherique."

There is one point absolutely essential to the success of making the granules play in this manner—they must be able to move freely in the fluid, any tendency to become flocculent, or to sink to the bottom in a mass, instantly stops this pattern forming; in this case spots may be formed in the compacted granule masses, as explained in a previous article (KNOWLEDGE, December, 1897), but no granule patterns will play on the surface.

Now, if these artificial granules truly represent the behaviour of the solar granules, it is evident that the conditions on the sun when spots are formed are exactly the opposite of those when reticulations are fashioned, the former depending on the compactness, and the latter on the diffusiveness of the photospheric materials.

Consequently, it became important to ascertain at what period of sun-spot activity Sir W. Huggins' drawing was made. Sir William very kindly informs me that "the drawing was made on April 26, 1866, one year before the minimum, the previous minimum of 1856 having been a remarkable one. The diagram does not represent the actual appearance of any one area of the sun's surface, but some of the more characteristic of the modes of grouping of the bright granules."

It seems to be always taken for granted that maximum "sun-spottedness" and maximum solar activity are the same thing—in fact, convertible terms. I venture to submit that it may be nothing of the kind, but the exact opposite may be nearer the truth: when the solar energy is at its maximum the photosphere may be so torn and churned and dispersed that it has not compactness enough left for spots to be able to form, and if

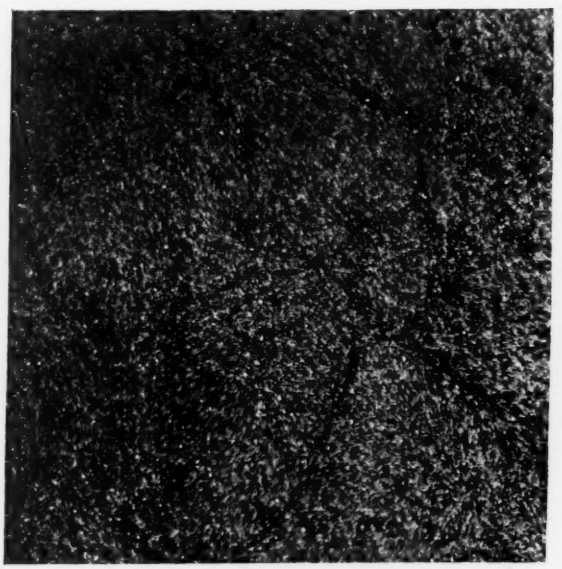


Fig. 2.—Artificial Solar granule pattern.

some few form they are small and soon obliterated. M. Janssen observes:—

"J'ai pu constater, par nos series photospherique que quand le soleil est a l'epoque d'un minimum, les taches ont une surprenante tendance à se dissoudre. L'annee 1876 en presente plusieurs examples remarkables."

I would suggest that spots are a sign of reviving solar fury, which does not reach its maximum until it has

rent the sun's outer garment into shreds and tatters and the sun-spot minimum has arrived.

It may be objected that even at a period of sun-spot maximum the total area occupied by spots is very small

Fig. 3.—Photograph of the Sun's Surface, showing granule pattern.

relatively to the solar surface, and that we should see more signs of this enormous disturbance of the photosphere if it really existed; but if reference is made to Professor Hale's spectro-heliographs given in KNOWLEDGE for August, 1898, it will be seen at once that the solar surface is vastly more disturbed than the spots shown telescopically give any indication of, and, indeed, that the telescopic appearance of the sun is exceedingly misleading. As was to be expected, sun-spots are after all only symptoms of the state of the photosphere, which may or may not be in a spot-forming state, a fact which, owing to the extreme interest attaching to the spots themselves, one is perhaps often inclined to forget.

Again, there is the obvious reply that the magnetic curve so closely follows the sun-spot curve that we are obliged to allow that when the magnetic curve indicates a maximum of magnetic disturbance the sun-spot maximum curve must also indicate a maximum of solar disturbance; but the conclusion is not necessarily true, and I would urge that the electricity generated by a rush of escaping steam, say, from a volcano, or from a boiler, depends not on the volume of steam, nor on the fierceness of the fire below, but on the friction of the steam against the sides of the orifice, and that the same volume of steam, if it were free to escape where it would, might generate no electricity at all. The two cases may not be parallel; magnetic storms may not be caused by the in-rush or out-rush of vapours in a great sun-spot; but until we know what the cause is it would not be at all safe to infer a maximum outbreak of solar energy because we find a maximum magnetic disturbance.

Or, again, it may be said that the prominences by their number and height must clearly indicate, coming as they do so markedly in direct proportion to the sun-spot maximum, that solar activity, the sun-spot maximum, and the prominence maximum are synchronous.

It is agreed that the prominence maximum synchronises with the spot maximum. I claim it as a strong proof of the theory now advanced; if a common gas jet is partly obstructed the flame will shoot out a surprising distance, and the smaller the orifice the longer the jet; so when the photosphere is diffuse as it is, ex hypothesi, at minimum the solar flames have but little altitude, when compact all the force is concentrated at the openings of the spots and vast jets of flame are expelled.

There are some important consequences which will follow if the foregoing explanation of the cause of granule patterns be admitted as a true one; the explanation, namely, that the absence or presence of spots depends on the free floating of the solar granules in the vapours out of which they are formed; or, on the contrary, on their subsiding into strata much denser and nearer to the solar surface. The Poles will never exhibit spots, for there the photospheric matter will always be too closely packed, owing to slowness of rotation, for the surface to be broken through; as the churning of the photosphere, produced by a maximum, subsides the granules will gradually sink down again first towards the Poles where rotation is least; when the new spot cycle will again begin, and continuously sink towards the Equator, whither the spots will follow.

The question of the irregularity of the eleven-year cycle will then be a question as to how quickly or how slowly the granules composing the photosphere are allowed to sink down after a maximum outburst of solar energy, and each sun-spot period will depend in some degree on the state in which the photosphere was left by the preceding one.

The cause of the eleven-year cycle itself remains, of

Fig. 4.—Artificial Solar granule pattern.

course, still untouched, but possibly if the cause of the irregularities were known we might get some hint as to the direction in which to look for a solution of the main problem.

XUM

PHOTOGRAPHS OF THE NEBULÆ M. 8 SAGITTARII AND OF H VI. CETI.

By ISAAC ROBERTS, D.SC., F.R.S.

NEBULA M. 8 SAGITTARII.

R.A. 17h. 57m. 33s. Decl. 24° 23′·0 South.

THE photograph was taken with the 20-inch reflector on the 11th July, 1899, between, sidereal time, 18h. 2m. and 19h. 32m., with an exposure of the plate during ninety minutes.

Scale—one millimètre to twenty-four seconds of arc.

The nebula is referred to in the N.G.C. No 6523, G.C. 4361, *h* 3722.

The photograph shows it to be a cloud of nebulous matter extending in *north following* to *south preceding* direction forty-eight minutes of arc, and about the same extent in *south following* to *north preceding*. Near the *preceding* end the nebulosity is dense, with a bright star apparently touching the margin, and giving it, on the negative, the appearance of an eye on one side of which is a prominent space free from nebulosity; there are also extensive spaces in some parts of the nebula which are almost free, and some quite free, from nebulosity; these give it a structural appearance.

There are many stars of between 8th and 17th magnitude either involved or seen in projection upon the nebula, and on the following side they resemble a cluster of bright stars, but I do not think they are physically connected with it; they are probably between the earth and the nebula.

The place we should, with our present knowledge, assign to this nebula in the order of stellar evolution, would be an early state prior to a spiral formation.

But we must have patience as well as moderation in our speculations, for millions of years will probably elapse before it is completely developed into a cluster of stars.

NEBULA H VI. CETI.

R.A. 0h. 42m. 36s. Decl. 25° 50′·6 South.

The photograph was taken with the 20-inch reflector on the 25th December, 1899, with an exposure of the plate during ninety minutes.

Scale—one millimètre to twenty-four seconds of arc

The nebula is referred to in the N.G.C. No. 252, G.C. 138, *h* 61=2354, and is figured by Herschel in the *Phil. Trans.*, 1833, Pl. 14, Fig. 52, p. 495. Also by Lassell in the *Mem. R.A.S.*, Vol. XXXVI., Pl. 1, Fig. 1, p. 40.

The photograph shows the nebula to be a spiral viewed at an acute angle. It measures twenty-four minutes of arc in diameter, which is in the direction *north preceding* to *south following*, and is studded with numerous condensations of a stellar character; there are also six stars, of the normal type, which are probably seen in projection upon it. These, together with the stellar condensations, will afford reliable fiducial points for the measurement from other stars around the nebula with the object of detecting any movements either of rotation or of translation that may in future take place in it.

Both these nebulæ are between twenty-four and twenty-six degrees of south declination; they can therefore be photographed under much more favourable conditions in observatories near, or to the south of the equator, and there can be no doubt that Dr. Gill at the Cape, or Prof. Pickering, will give a good account of them.

If we consider the nebula H VI. Ceti with reference to the evolution of stellar systems its place would be far in advance of M. 8 Sagittarii. In this the convolutions are not only formed but the development of the stars in them has also reached an advanced state; some of them appear like small well-formed nebulous stars; and the nebula in time—who can imagine how long—will appear as a star-cluster, and resemble those which have already been photographed and described in the volumes of "Photographs of Stars, Star-Clusters, and Nebulæ."

ASTRONOMY WITHOUT A TELESCOPE.

By E. WALTER MAUNDER, F.R.A.S.

V.—OBSERVATIONS OF THE SUN.

IT may seem at first sight a useless and idle suggestion that beginners in Astronomy should set themselves to the redetermination, on the roughest scale and with the simplest of instruments, of astronomical constants which were first determined more than five millenia ago, and which are now ascertained in our modern observatories to an almost inconceivable degree of exactness. Yet if we think for a moment we shall see that this is but the method which experience has taught us is the most effective in learning the other physical sciences. We know perfectly well we can never make a chemist of a boy by giving him a course of chemical text-books. We set him to repeat for himself experiments which were first made in the very infancy of the science. We make him determine again the combining weights of different elements, though these are known far more exactly than he can possibly work them out; and in so doing, he not only acquires skill as a worker, but the subjects of his study become real to him; he learns to know them in a sense which no amount of reading about them could ever supply.

It has been the drawback of Astronomy that this course has so seldom been adopted, and the inevitable result has been seen in that no science whatsoever has produced so large a proportion of paradoxers and cranks. There is no science, the chief facts of which are so widely disseminated; there is none of which those facts are so little known by practical personal observation.

Much of this unfortunate state of things is due simply to the modern tendency to live in towns. Here the smoky atmosphere dulls the shining of the heavenly bodies; the crowded buildings hide the horizon and curtail the view of the sky, and at night the artificial lights in streets and houses completely drown the feebler glitter of the stars and draw off attention from them. We do not need moon and stars as our ancestors did, and therefore we do not notice them. We do not need to observe the sun to give us the time of the year; our almanacs tell us that. Therefore, except in observatories, the sun's place in the heavens remains unnoted.

But in early times this observation was of the very first importance. The constellations as we have seen, were mapped out some 5000 years ago. (KNOWLEDGE, February, 1900, p. 37.) Before that was done—how long before we cannot tell—the length of the year had been determined and the apparent path of the sun amongst the stars had been laid down. The exact methods and instruments those early astronomers employed are not recorded, nor, if they were, would there be any reason for slavishly copying them in repeating the work to-day. But in all probability the first astronomical instrument was one of Nature's own providing, the natural horizon. And wherever a fairly good one is available, the beginner in astronomy is strongly recommended to make use of it.

If this were so then no doubt those primeval observers

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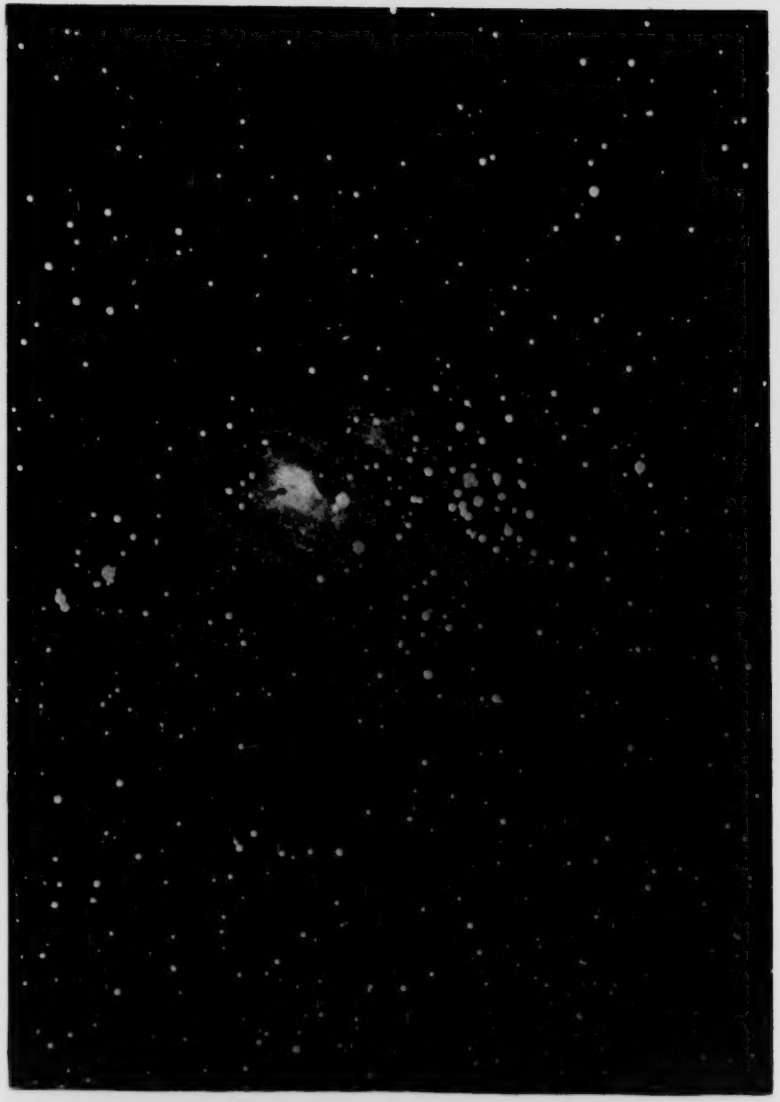
NEBULA H VI. CETI.



NEBULA M. 8 SAGITTARII.

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had their attention drawn to the fact that as seen from some given station the sun rose and set behind different portions of the horizon at different times of the year. In an open country free from mists and ground fogs, this observation would be one of greater delicacy than might be expected—a delicacy the greater according to the distance of the horizon and to the number and distinctness of the objects which could be recognised upon it. They would serve the purpose—so to speak—of the divisions of a gigantic azimuth circle, and a few years' careful and sedulous record of the exact position of the sun at rising and setting would give an exceedingly close determination of the true length of the tropical year.

They would do more than this. They would give the means of determining the south point of the horizon—in other words of the meridian line. A line drawn at right angles to the line joining the point of rising and setting, would be *roughly* but not precisely the meridian line. But the mean of all the points this indicated as due south would, unless the horizon were much more obstructed on one side than the other, approximate very closely indeed to the true south point.

The conditions for different observers will vary so widely that it would be useless to give detailed directions as to making this observation, and it would be useless for another reason. It is most important that those who take up the pursuit of naked eye Astronomy should make their observations independently, and too detailed instruction beforehand would defeat the very object for which those observations were made.

It would soon be felt that the natural horizon was a rough and inconvenient instrument to work with. The objects ranged along it which serve as division marks are apt to be irregular, the horizon itself to deviate very considerably from an ideal plane. So perhaps the next step in the observation of the sun would be the erection of some means of observing the shadow it casts—in other words a simple sun-dial.

It is probable that the earliest sun-dial was simply the spear of some nomad chief, stuck upright in the ground before his tent. Amongst those desert wanderers, keen to observe their surroundings, it would not be a difficult thing to notice that the shadow shortened as the sun rose higher in the sky, and that the shortest shadow always pointed in the same direction—north. The recognition would have followed very soon that this noonday shadow changed in its length from day to day. A six-foot spear would give a shadow at noonday in latitude 40° of 12 feet at one time of the year, of less than 2 feet at another. This instrument, so simple, so easily carried, so easily set up, may well have begun the scientific study of Astronomy, for it lent itself to measurement, and science is measurement; and probably we see it expressed in permanent form in the obelisks of Egyptian solar temples, though these no doubt were retained merely as solar emblems ages after their use as actual instruments of observation had ceased. An upright stick, carefully plumbed, standing on some level surface, may therefore well make the first advance upon the natural horizon. A knob at the top of the stick will be found to render the shadow more easily observed.

The careful study of this instrument will enable the meridian line to be marked with some considerable exactness. This should be done by taking an observation at some time in the morning, a good while before noon, drawing a circle with the base of the stick as centre, and the length of the shadow as radius, and then in the afternoon watching till the tip of the shadow again lengthens itself to exactly reach the circle. We shall find the north point lie midway between the two positions of the shadow. Here again we must trust not one observation but many, and the mean will give us a very close approximation to the true meridian.

The date of the summer or of the winter solstice would not be very readily ascertained from such an instrument—the very word solstice intimating that the change in the sun's position at that season is scarcely perceptible. But the time of the equinoxes can be fixed with sufficient exactness, since the length of the noonday shadow of a six-foot rod will vary in our latitude more than an inch a day at that time of the year.

A far exacter instrument for the observation of the sun can be made with the very slightest trouble; a light tube, 5 feet 4 inches long, made either of tin or of pasteboard, and covered at one end with a cardboard disc, with a pinhole one-sixteenth of an inch in diameter, carefully perforated in its centre, and at the other with a cap of oiled paper, will enable the sun to be observed with great ease. If this tube is directed to the sun an image of the sun will be formed by the pinhole on the oiled paper some six-tenths of an inch in diameter, and if a cardboard disc some ten or twelve inches in diameter is fixed to the tube—the tube passing through the centre of it—so as to screen the observer from the rays of the sun, he will find the sun's image on the oiled paper quite bright enough to observe, and much better defined than the shadow given him by the rod.

The next step would be to fit the tube with a graduated circle. The material of which the circle should be made and the manner in which it should be graduated may be left to the ingenuity of the student. Protractors of horn, metal, glass, or card can be very easily purchased and may well serve the purpose. The reading of the circle may be accomplished in one or two ways; the circle may be fixed firmly to the telescope so as to turn with it, and the altitude of the tube may then be read by a plumb-line dropped from the centre of the circle across its circumference; or the circle may itself be fixed in one position with respect to the vertical, and the tube may be turned round upon the same centre as that of the circle. In this case the tube should be supplied with pointers to read on the circle.

The tube being provided by a vertical circle and constructed so as to turn in a vertical plane, should also have its stand so arranged that it may turn in a horizontal plane also, and it should be fitted with a second circle, the centre of which the pivot on which it turns. This circle must be fixed in the horizontal plane, and our instrument will then be a rough model of an altazimuth.

Its first use will be to determine the meridian—by taking an observation in the morning reading both circles—then in the afternoon, waiting until the sun had descended to the same altitude a second time, and then reading the azimuth circle again. To set the telescope to the azimuth midway between these two azimuths would be to set it roughly in the meridian. Here again the observations should be repeated many times, and the mean should be taken as the true south point.

The south point once found, the observation of the varying altitude of the sun at noon from day to day throughout the year would be a simple and easy matter. At midsummer and midwinter the meridian altitude of the sun will not vary perceptibly for a fortnight or

more, so that we shall obtain a number of observations for the greatest and least height of the sun Half the difference between these two must plainly be the obliquity of the ecliptic; and the altitude which is the mean of these two extreme altitudes must be the altitude of the equator, that is to say of the sun when it is at the equinox. The date of the equinox will be determined to the nearest day without any difficulty, for if we set our tube in the meridian, and pointing to the equator—in other words at an altitude equal to the co-latitude of our station—a single day's variation in the height of the sun at the time of the equinox will make a change in the position of the sun in the field of our pinhole tube of about four-tenths of an inch—an amount which the very roughest of observers could not overlook.

Such an instrument, simple as it is, would therefore enable the observer to determine the date of the equinox to the nearest day, and consequently the length of the tropical year, and also the obliquity of the ecliptic and the co-latitude of the place of observation. The exactness with which these could be determined would depend upon the skill and patience of the observer, who could, ere long, if he were sufficiently exact, begin to detect causes of irregularity in his results, some due to defects in his instrument, and some due to causes apart from that apparent motion of the sun which it was his first object to determine. These we must leave for the present, though their detection and the discovery of their cause would give a keen delight to anyone with a true observer's spirit, especially when he found that a proper allowance for them brought his observations into ever closer and closer accord.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

SEARCH FOR AN INTRA-MERCURIAL PLANET.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—With reference to Prof. E. C. Pickering's proposal to search for an intra-mercurial planet during the total phase of the solar eclipse of May 28, I should like to remark that if such a planet exists it is probably *exceedingly small*. In fact it must be too small to be distinguished when in transit over the sun, or it would certainly have been discovered long ago unless indeed its orbit is much inclined, and it is enabled to pass N. or S. of the sun at its conjunctions, which is highly improbable. The instances of rapidly moving dark spots quoted by Webb may be dismissed as too doubtful to throw any definite light on the subject. The observations are too imperfect to afford data for the satisfactory computation of the orbit, though Lescarbault's reported discovery of 1859, March 26, enabled M. Le Verrier to derive approximate elements. But Lescarbault's description is probably the most untrustworthy of all, for the same observer announced to the Academy of Sciences on 1891, January 11th, that he had discovered a bright body in Leo, which he could not identify, and had therefore concluded it to be a new star. This "new star" proved to be the planet Saturn! Lescarbault, so easily deluded in this case, was no doubt similarly mistaken in 1859, when a normal sun-spot must have encouraged visions of a mobile planetary body. In this connection it may be added that M. Emmanuel Liais, whose decease has recently been announced, was watching the sun in Brazil at the very hour when Lescarbault thought he had detected "Vulcan," and positively averred that no object of the kind was visible.

At various times I have obtained some thousands of solar observations with different instruments, but chiefly with refractors of 4½in. and 3in., and a reflector of 4in. aperture with a view to the detection of an intra-mercurial planet. The months of observation were usually March—April, and September—October. On some days the sun was examined at short intervals during the whole time that he remained above the horizon, but I never met with any object representing an intra-mercurial planet. Occasionally a suspicious looking spot—pretty round, small, and without penumbra—was noticed, but upon being closely watched it always proved a veritable sun-spot. I believe that spots with certain planetary aspects appear more often than is generally supposed, and perhaps it is no wonder that their character has been sometimes mistaken by persons who have formed hurried conclusions without applying proper tests.

W. F. DENNING.

Bishopston, Bristol,
May 5th, 1900.

S. U. CYGNI.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—As but little so far as I know has been published of the movements of Miller & Kempf's Variable, designated by them as S. T. Cygni, and by a late writer in the *Astronomical Journal* as S. U. Cygni, the following observations though lengthy may be worthy of a portion of your valuable space.

Date.	Magnitude observed.	Maximum due. G.M.T. D.	H.	M.
Augt. 24	6·51	Augt. 23	17	39
,, 27	6·51	,, 27	13	55
,, 28	7·07			
,, 29	7·22			
,, 30	7·22			
,, 31	6·71	,, 31	10	10
Sept. 1	6·71			
,, 23	6·91			
,, 4	6 63	Sept. 4	6	25
,, 5	7·12			
,, 7	7·17	,, 8	2	41
,, 9	7·08			
,, 11	7·15	,, 11	22	56
,, 12	6·66			
,, 13	7·13			
,, 14	7·25	,, 15	19	11
,, 21	7·96	,, 19	15	27
,, 22	7·10			
,, 23	7·13	,, 23	11	02
,, 25	7·08			
,, 26	6 98			
,, 27	6·49	,, 27	7	58
,, 29	7·18			
,, 30	7·18			
Oct. 1	7·18	Oct. 1	4	13
,, 2	7·19			
,, 3	7·30			
,, 5	6·79	,, 5	0	29
,, 7	7·27			
,, 8	7·30	,, 8	20	45
,, 9	6·71			
,, 10	7·35			
,, 12	7·38	,, 12	17	00
,, 13	6·89			
,, 14	7·27			
,, 15	7·27			
,, 16	6·58	,, 16	13	15
Oct. 15	7·27			
,, 16	6·58	Oct. 16	13	15
,, 18	7·11			
,, 19	7·10			
,, 20	7·08	,, 20	9	30
,, 21	7·08			
,, 22	7·27			
,, 23	7·35			
,, 24	7·08	,, 24	5	45
,, 24	6·08			
,, 25	6·56			
,, 26	7·21			
,, 28	6·97	,, 28	2	00
,, 29	6·93			
,, 30	7·39			
,, 31	7·32	,, 31	22	16
Nov. 3	7·20			
,, 5	6·79	Nov. 4	18	31
,, 15	6·85			
,, 19	7·27	,, 20	3	32
,, 22	7·23	,, 23	23	47
,, 23	6·94			
,, 28	6·95	,, 27	20	02
,, 30	7·13	Dec. 1	16	17
Dec. 2	6·61			
,, 3	7·12			
,, 4	7·19			
,, 5	6·56	,, 5	12	32
,, 11	7·31	,, 9	8	48
,, 12	7·31	,, 13	5	03
,, 15	6·56			
,, 16	7·06	,, 17	1	18
,, 25	6·71	,, 24	17	48
,, 26	6·56	,, 27	14	04
,, 28	6·30			
		,, 30	10	19

These observations were made in the evenings not later than 8 p.m. local time, which is six hours and twelve minutes behind G.M.T.

Following the elements given by the discoverers I have given the dates upon which maxima were due G.M.T. Their period is 3.844 or 20h. 15m. 21.4, while Luzette's (Paris) period is 3.846 or 20h. 18m. 14·2,

making quite a difference. To what I have said of this star in March KNOWLEDGE I will add nothing till I see more of it. DAVID FLANERY.

Memphis, Tenn., U.S.A.,
11th April, 1900.

WIRELESS-TELEGRAPH RECEIVER.

Mr. R. Child Bayley, Editor of *Photography*, writes to us:—

"The interesting letter from Mr. Norman Robinson in your May issue and the appeal by Mr. Little, leads me to think that possibly those gentlemen may not be acquainted with the very remarkable paper by Mr. Glew read before the Royal Photographic Society about a year ago. In that communication the author described a method by which it appeared perfectly possible for the Hertzian disturbances to which a flash of lightning gives rise, so to actuate the shutter applied to a camera, that the plate itself should be exposed to record the lightning before the light waves had time to reach the plate"

This paper was published in the *Photographic Journal* of March, 1899.

ORNITHOLOGICAL NOTES.—In the absence from England of Mr. Harry F. Witherby, the Ornithological Notes are held over.

Notices of Books.

"Text-book of Palæontology." By K. A. von Zittel. Translated and edited by C. R. Eastman. Vol. 1. (Macmillan.) Illustrated. 25s. net. Professor von Zittel's "Handbuch" and the smaller "Grundzuge (Outlines) der Paleontologie" have attained such a world-wide reputation, and contain such a vast amount of matter which can be found nowhere else within the limits of a single work, that it is a matter for congratulation that the latter is at last produced (so far as the Invertebrates are concerned) in English. The English edition has been undertaken by Mr. Eastman, of Harvard College, with the assistance of a brilliant staff of American specialists; and the result seems, as might have been expected, all that can be desired. At the commencement of the undertaking it was intended to give a literal translation of the German original of the "Grundzuge," but as the work progressed it was found, with the lapse of time since the publication of the former, the incorporation of so much new matter was essential in order to bring it up to date that this became a practical impossibility. Accordingly, after the translation of the chapters on Protozoa and Cœlenterata, which stand almost in their original form, it was determined, with the assent of the author, to rewrite and expand the remaining sections so as to bring them thoroughly abreast of the present state of science. It will be found, therefore, that while some of the later chapters, especially the one on the Mollusca, are but little altered from the German text, a large portion of the work, although following the general lines of the original, is practically a new production. A praiseworthy feature is the large amount of bibliographical matter added in the form of foot-notes, which renders the work more valuable not only to the ordinary student, but likewise to the advanced specialist.

Taken as a whole, the work is written in a much more technical style than the corresponding portion of the "Manual of Palæontology" by Nicholson and Lydekker; and it cannot, therefore, in any sense be regarded as a "readable" volume, in which the mere amateur will find delight for his leisure moments. It is, in fact, a purely scientific manual, written for students and scientific men; and as such may lay claim to the highest praise. To assimilate its contents the reader must, indeed, be well acquainted with the meaning of a large vocabulary of abstruse terms; and almost the only improvement we can suggest would be the addition of a glossary of such terms.

In a brief notice like the present it is impossible to attempt criticism; and we can only state that the definitions are drawn up with a precision and preciseness which are really admirable, while the illustrations (reproduced from the original) are all that can be desired. Especial attention may be directed to the figures of Ammonites, in which the form of the complicated "sutures" is in most cases clearly shown on a small segment of the shell in a manner rendering easy the determination of the generic characters. We hope before long to have the opportunity of according an equal hearty welcome to the Vertebrate section of this most valuable and important work.

"The Boyhood of a Naturalist." By Fred Smith. (Blackie.) 3s. 6d. It is only once in a while that we come across such an optimistic book as the one under notice. All who wish to recall the happy days of boyhood, and to again rehearse the buoyancy of youth—and who does not?—will do well to read this most exhilarating narrative of a naturalist. The author, as a boy, was devoted to natural history, and preferred a country ramble ten times over to a game of cricket. He relates the stratagems by means of which he avoided the national pastime, and the fines he had to pay as the result of following the bent of his mind. Very amusing is the account of a lecture on the snail given by the author as a boy of twelve years of age, and the enthusiastic description of the building of an aquarium will afford delightful reading. We feel sure that the decidedly charming way in which the author has narrated his experiences will commend itself to all young people who are fortunate enough to gain access to the book, the pages of which will indeed appeal to all lovers of nature whether of large or small growth.

"A First Book of Organic Evolution." By D. K. Shute, M.D. (Kegan Paul.) Illustrated. 7s. 6d. net. "There is nothing great in the world but man, nothing great in man but mind, and nothing great in mind but character." Dr. Shute's idea as to the goal of evolution seems to be men with great minds of high character, and he holds that the subject is of such vast importance and commanding interest as to be a necessary ingredient in what is called a liberal education. The truth of the theory of evolution is herein assumed, and the author disposes facts collated by other observers in a way which he regards as most likely to be helpful to the beginner in finding the shortest route through the labyrinthine maze of ways and bye-ways investing the whole fabric. The title is misleading, as no one unacquainted with the elements of general biology can appreciate the theme, and, seeing that the book amounts to no more than an essay, the ground covered is too comprehensive to admit of the amplification necessary for those beginning the subject. A good bibliography is provided, and some excellent coloured plates adorn the text.

"Practical Exercises in Elementary Meteorology." By Robert De Courcy Ward. (Ginn.) The teaching of meteorology in this country, though scanty at present, is probably on the increase, and many who are engaged in it will regard with interest this American book, in which Mr. Ward offers us the fruits of some ten years' experience as "instructor in climatology" at Harvard (U.S.). American ways of dealing with weather, as well as American weather, differ from ours; and if this probably detracts from the usefulness of such a book "on this side," one may see compensating advantage in a widened view; perhaps, also, if we are not too "insular," in the discovery of some things brother Jonathan does better than ourselves. After showing how weather may be studied, so far, without instruments, the author gives a good account, first of "elementary," then of "advanced," instrumental observations (a somewhat rough distinction, of course). With the aid of a sheet of weather data for six days at a number of American stations, the pupil is next shown, in an interesting way, how to draw isotherms, isobars, wind-arrows, etc., and generally prepare a "daily weather map." Further on, he learns to make "composite portraits" (not photographic) of various features of cyclones and anticyclones. Then we have a discussion, in eleven chapters, of the correlation of certain elements of weather, and weather forecasting; next, six chapters on "problems of observational meteorology," followed by 24 pages of tabular matter relating to humidity, dew-point, etc. A frequent practice throughout the book is that of telling the pupil to do this or that, and then putting a number of suggestive questions as to what he finds when he has done it. In the section on instruments the author might have been more explicit as to the best hours for observing temperature, etc. The nephoscope is described, but not the sunshine recorder (which is growing in importance with us). The weather table lacks dates, and is incorrectly referred to in several places as "the table in chapter VIII." (where it is not). This chapter is headed "weather," but the word is, confusingly, sometimes restricted (as here) to the state of the sky, and precipitation, occasionally used in the common wider sense. Mr. Ward, in general, writes clearly and well; though here and there doubtful statements are met with. There is also some useless repetition (compare, e.g., what is said of the sirocco on pp. 103 and 133). Indeed the general plan of the book tends, we are afraid, to repetition. Apropos of this, we note the remark (p.183) that "the correlation exercises will, as a whole, teach few entirely new facts to the brighter scholars who have faithfully completed the preceding work." The aim appears to be to "impress firmly" the lesson "by repeated illustrations." Still, we are

XUM

inclined to think those later sections might be improved by a little condensation, if not rearrangement. Once more, the subject of thunder-storms and atmospheric electricity is hardly touched upon. Having said this much in criticism, we heartily commend the work as one likely to be of real service to the school teacher and others. The "get-up" of the book is excellent. There is an appendix containing suggestions to the teacher, and another on the equipment of a meteorological laboratory.

"Annual Report of the Board of Regents of the Smithsonian Institution for the year ending June 30th, 1897." Report of the United States National Museum. Part I. (Washington Government Printing Office.) This report consists of two parts, the first being the report of the acting assistant-secretary of the Smithsonian Institution in charge of the National Museum, the second embracing papers describing and illustrating collections in the museum. The report forms a handsome volume of over a thousand pages, with upwards of five hundred illustrations. It is distributed gratuitously with lavish munificence, as many as ten thousand copies being in this way disposed of. If, in face of facts like these, it is permissible to offer a kindly criticism, we should like to suggest that the world has been reminded by the greatest of ethical authorities that the heathen will not be heard by reason of their much speaking. It is similarly possible to write too voluminously, and there is, we think, a disposition on the part of our American contemporaries to suppose that the importance of a publication is magnified by increasing its length, rather than concentrating its contents. But there can be no question of the value and importance of this latest addition to a wholly valuable series. The descriptive catalogue of recent foraminifera which Dr. Flint has compiled, with the eighty beautiful plates accompanying the monograph, will prove a mine of wealth for students of this interesting branch of the protozoa. The account of the pipes and smoking customs of the American aborigines, based upon the material in the United States National Museum, which Mr. Joseph D. McGuire contributes, runs to nearly three hundred pages, and being provided with well over two hundred pictures, exhausts, we should suppose, nearly everything that can be said on the subject. Mr. Wert Tassin writes in a similarly exhaustive manner on the "Properties and Classification of Minerals." Mr. George H. Cooke deals with "Easter Island," and Dr. Otis Tufton Mason with the man's knife among the North American Indians. The remaining part of the volume is occupied with an account of the arrow points, spear-heads, and knives of prehistoric times, by Dr. Thomas Wilson. A mere statement of the contents of the volume indicates the wide range of subjects comprised, but to impart anything like an adequate conception of the sumptuous character of the feast which is here set before the reader is quite impossible in a short review. We can only hope it will be possible for students to examine the volume itself in one of our national libraries, since it is only in this way that an appreciation of how things are done in America is possible.

"Practical Zoology." An Elementary Course of Practical Zoology. By the late T. J. Parker and W. N. Parker. Macmillan's Manuals for Students. London. 1900. Price 10s. 6d. It is sometimes made a reproach to the zoological workers of the present day that they deal too much with "outside zoology"; but the publication of a volume like the present does much to remove this reproach, at least so far as a selected series of typical animals are concerned. The work before us is indeed essentially of the "section-cutting" type; and puts before the student in a lucid manner the mechanical construction of representatives of the leading groups of animals, together with the functions of the different organs described. The work is to some extent an expansion of the plan followed in the second half of the late Prof. Rolleston's "Forms of Animals," but gives a much greater preponderance to the Vertebrates as compared with the Invertebrates. Since, however, the book is intended for medical students (among others) the large amount of space devoted to the former group is an advantage rather than otherwise; and in any case, as the authors themselves state, a comparative study of the several types of Vertebrates forms as good a training for beginners as can be desired. Whether, however, the title chosen for the work is altogether a happy one, may be an open question. In our own opinion the term "practical zoology" is at least as applicable to the description of the external forms of animals, and the observations of their habits in the field (the true work of the naturalist), as it is to section-cutting in the laboratory; and "Practical Anatomy" would better have expressed the nature of the subject of the present work. Commencing with a general sketch of the scope of biology, the authors take the frog as an example from which to illustrate the structure of animals in general. After treating its anatomy in great detail, they then take a series of animal types to illustrate the gradual progression from the simple to the complex, beginning with the Amœba, and ending with the rabbit. After describing the Monads and Bacteria in one chapter, and the Rotifers and their allies in a second, the Messrs. Parker follow on with Hydra as an example of the Cœlenterata; while the earth-worm does duty for the Annulata, the cray-fish for the Arthropods, and the pond-mussel for the Molluscs; the lancelet, the dog-fish, and the rabbit (in addition to the frog) serving as illustrations for the Vertebrates. A better selection could not have been made; and the extensive experience of both authors in teaching has enabled them to bring into prominence just those points on which the attention of the students should be concentrated. And as the descriptions of the dissections are (with the help of the illustrations) admirably adapted for their purpose, the book should command a large circulation among the zoological students of our science schools.

"The Standard Intermediate School Dictionary of the English Language." By James C. Fernald. (Funk and Wagnalls Co.) This nicely printed school dictionary, with its 800 pictorial illustrations, is an abridgment of Funk and Wagnall's Standard Dictionary. It gives the orthography, pronunciation, meaning, and etymology of about 38,000 words and phrases which are common in the language and literature of English-speaking people. It is already widely used in the schools of America, where it was first published. There are, however, already so many good school dictionaries in this country that we suspect that it is not likely to attain a great popularity with our schoolmasters. A want of precision is exhibited in the meanings assigned to certain scientific terms we have looked up, e.g., "asteroid" is defined as "one of a group of small bodies between Mars and Jupiter," but, as children in secondary schools are more familiar with Roman deities than with the planets, the vagueness of the explanation is likely to cause confusion. Or, again, "basalt" is said to be "an igneous rock of a dark colour and often of columnar structure," but the same thing is more or less true of igneous rocks which no one would call basalts.

"The Makers of Modern Prose: a popular Handbook to the greater Prose writers of the Century." By W. G. Dawson. (Hodder & Stoughton.) 6s. This is the second volume of Mr. Dawson's projected series on the makers of modern English, and it forms in the main an acute and discerning appreciation of some of the makers of modern prose, beginning with Johnson and concluding with F. W. Robertson. The writer appears to have included Froude in his selection for no other reason than to exhibit that unhappy writer as an example to be avoided. He should have been more appropriately included in the last volume of the work, which is to deal with the makers of modern fiction.

"The Natural History of Echinoderms." A Treatise on Zoology. Edited by E. R. Lankester. Part III. The Echinoderma. By F. A. Bather, assisted by J. W. Gregory and E. S. Goodrich. (London: A. & C. Black.) 1900. Cambridge having started a "Natural History" of its own, the sister University has deemed it advisable to enter the same field with a work bearing the more pretentious title of a "Treatise on Zoology," or as the editor would apparently prefer to call it, a "Treatise on Animal Morphography." The Cambridge series is written on somewhat popular lines, while the present one, as is stated in the editorial preface, is addressed to the serious student of zoology. And there can be no question but that the authors of the present volume, which is the first of the series to appear, have treated their subject in a very serious manner indeed. No one but the student who desires to master a very technical subject in all its details is at all likely to be tempted to dip into the pages of the volume before us. For the advanced student of the palæontology and morphology of the Echinoderms (that is to say, sea-urchins, star-fishes, sea-cucumbers, stone-lilies, and their extinct allies) the work seems, however, to be all that can be desired, and will doubtless long remain the standard treatise on the subject. For a "Treatise on Zoology" the present volume is remarkable for the large amount of palæontology it contains; no less than 169 out of a total of 332 pages being devoted to groups which are for the most part entirely extinct. In the case of a group like the Echinodermata (as we prefer to call it) such a treatment was inevitable if the subject was to be made anything like complete; and this bold disregard of popular prejudices affords testimony, if such were required, of the Editor's comprehensive view of the meaning of "zoology." The Echinoderms have indeed suffered almost more severely at the hands of time than any other group of animals that is still strongly represented at the present day; and no proper understanding of the existing representatives of the group can be gained without an intimate acquaintance with the hard anatomy of their fossil predecessors. As we learn from the preface, the series of works is to be written, so far as practicable, by graduates of Oxford; and it is a fortunate circumstance that, while possessing this qualification, Mr. F. A. Bather, in this country at least, is facile princeps in his knowledge of the extinct classes of the Echinoderms. The portion of the work dealing with the Cystids, Blastoids, Crinoids, etc., has accordingly been assigned to him; while he has also written the chapter on Holothurians. On the other hand Dr. J. W. Gregory is responsible for the account of the Star-fishes, Brittle-Stars, and Sea-urchins. A feature of the volume is the number and beauty of the illustrations,

which are for the most part original; and an examination of these is alone sufficient to show the extraordinary amount of care and labour the authors have bestowed on their subject. Evidently they had their whole hearts in their work; and the result will contribute in no small degree to the well-deserved reputation they already enjoy. The general classification of the group is the one now usually accepted, save that Dr. Gregory has considered it advisable to brigade the Asteroidea (Star-fishes) and Ophiaroidea (Brittle-stars) in a single class. In this he is no doubt justified, but we question whether linguistic purists will accept the hybrid term "Stelleroidea" as the title for the class as thus extended. In our own opinion it would have been preferable to have employed "Asteroidea" in this sense; designating the sub-classes "Asteroidea Vira" and "Ophiaroidea."

"The Teaching of Geography in Switzerland and North Italy." By Joan Berenice Reynolds. (C. J. Clay & Sons.) 2s. 6d. This little book consists of the report which Miss Reynolds presented to the Court of the University of Wales on her visit to Switzerland and North Italy as Gilchrist Travelling Student, and it has been published because the Executive Committee of the University believe that the information it contains will be of material value to teachers, and to all those interested in education, an opinion in which we heartily concur.

"Journal of Researches." By Charles Darwin. (Ward, Lock.) Illustrated. 2s. Messrs. Ward, Lock and Co. have issued a new and cheap edition of Darwin's Journal of his voyage in the "Beagle," within chaste artistic covers which present a most agreeable appearance, and those with the most slender resources may now add this—one of the immortals—to their collection.

The ever-valued Kodak has again evolved a new variety, namely, the 1A Folding Pocket, the mechanism of which is of the familiar "folding-pocket" order, but the size of the picture—$4\frac{1}{4}$ by $2\frac{1}{2}$—is more pleasing.

Entomologists, ornithologists, botanists, and others interested in natural history, should have by them a copy of Messrs. Watkins and Doncaster's new Catalogue, which is issued in handy form. Taxidermists' tools, artificial eyes, birds' skins and eggs, cabinets, etc. are entered against figures which will meet with general acceptance.

BOOKS RECEIVED.

Primitive Constellations. Vol. II. By Robert Brown. (Williams & Norgate.) 10s. 6d.

Photo-Relief Map of Africa. (S.P.C.K.) 9d.

Origin and Character of the British People. By Nottidge Charles Macnamara. (Smith, Elder & Co.) 6s.

Alternating Currents. By W. S. Franklin and R. B. Williamson. (Macmillan.) Illustrated. 7s. 6d. net.

Electricity and Magnetism. New Edition. By Silvanus P. Thompson. (Macmillan.) Illustrated. 4s. 6d.

Zoological Results based on Material from New Guinea, Loyalty Islands, &c. Part IV. By Arthur Willey. (University Press, Cambridge.) Illustrated. 21s.

Papers on Mechanical and Physical Subjects. By Osborne Reynolds, F.R.S. (University Press, Cambridge.) Illustrated. 15s. net.

Primeval Scenes. By the Rev. H. N. Hutchinson. (Lamley.) Illustrated. 6s.

The Story of the Alphabet. By Edward Clodd. (Newnes.) Illustrated. 1s.

Journal of the Society of Comparative Legislation. April, 1900. 5s.

Elementary Practical Chemistry. By T. Cartwright. (Nelson.) 2s.

Travels on the Amazon. By A. R. Wallace. (Ward, Lock.) 2s.

Letters of Berzelius and Schönbein, 1836-47. Edited by Georg W. A. Kahlbaum. (Williams & Norgate.) 3s.

Negritos. By A. B. Meyer. (Stengel: Dresden.)

Note on the Unpublished Observations, 1774-1838, *Radcliffe Observatory.* By Arthur A. Rambaut, D.SC., Radcliffe Observer.

THE FIRST MUSK-OXEN IN ENGLAND SINCE THE GLACIAL EPOCH.

By R. LYDEKKER.

SOME persons are unfortunate in their names, and the same is the case with certain animals. The ruminant popularly known as the Musk-Ox and scientifically as Ovibos moschatus is an instance of this, for although no objection can be taken to the prefix "Musk," and its Latin equivalent moschatus, yet the English title "ox" is in the highest degree misleading, while the technical "Ovibos," which suggests characters intermediate between the oxen and the sheep, is equally unsatisfactory. To say that the creature is an animal sui generis would be a truism, seeing that it is the sole existing representative of the genus Ovibos; and yet this expression, perhaps, best conveys the real state of the case, namely, that it is a more or less isolated member of the ruminant group, coming under the designation neither of an ox nor a sheep, nor yet being a connecting link between the two. Under these circumstances it would be much better if the name "Musk-Ox" could be dropped altogether, and (unless it be altogether unpronounceable) its native Greenland equivalent adopted instead. Unfortunately, however, I have hitherto been unable to ascertain by what name the creature is known to the Greenlanders.

Although now restricted to Greenland and Arctic America eastward of the Mackenzie River, the Musk-Ox was formerly a circumpolar animal, its remains being occasionally met with in the interior of Alaska, more commonly in the frozen cliffs of Eschscholtz Bay, and also in the ice-bound soil of the Lena and the Yenisei valleys. Although unknown in Franz Josef Land and Spitzbergen, the Musk-Ox extends polewards through Parry Island and Grinnell Land into North Greenland, where its northward range is probably only limited by the limits of vegetation. South Greenland at the present day is, however, too hot for such a cold-loving beast, and Melville Bay now forms the southernmost point to which it wanders on the west coast. Consequently it would seem probable that the Musk-Oxen on the west coast are completely isolated from those on the eastern seaboard; the central mountain range of the interior of Greenland being apparently impassable even by such hardy animals, while a transit via Cape Farewell is, as we have seen, barred by climatic conditions of an opposite nature.

In America, however, the Musk-Ox still ranges considerably further south, its limits in this direction being approximately formed by the sixtieth parallel of north latitude; but it is stated that year by year its southern range is slowly contracting—possibly owing to pursuit by man When the Musk-Ox ceased to be an inhabitant of the Siberian tundra, or why it should ever have disappeared from regions apparently so well suited to its habits as are Northern Asia and Alaska, there are no means of ascertaining. But the date of its disappearance was probably by no means remote, comparatively speaking, and it is even possible that man himself may have taken a share in its extermination. However this may be, it is beyond doubt that the Musk-Ox was an inhabitant of the South of England, as well as of parts of France and Germany, during, or about the time of the glacial epoch; its remains occurring not uncommonly in the gravels of the English river-valleys, such as those of the Thames and Severn, as well as in the brick-earths of Kent. It is also probable that they occur in the "forest-bed" of the Norfolk coast, which somewhat antedates the great glaciation of Britain.

This being so, it is evident that the Musk-Ox was a living British animal within the period during which our islands have been inhabited by man, for in many of the deposits in which its remains occur flint-implements and other evidences of human presence are likewise found. Probably, indeed, the early human inhabitants of Britain not unfrequently made a meal of Musk-Ox beef; but the disappearance of the animal from the British fauna may apparently be attributed rather to a change in climatic conditions than to pursuit by man.

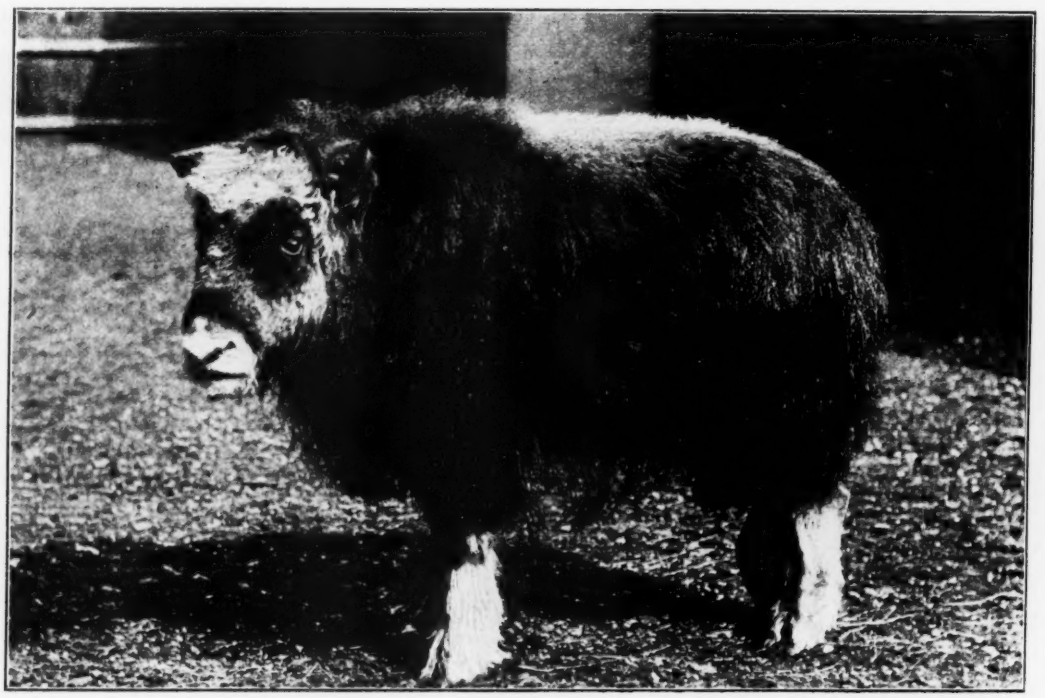
From that long distant day when the last indigenous British Musk-Ox departed this life no living represen-

XUM

tative of the species appears to have been brought to our islands till the autumn of last year, when a couple of young bulls were added to the collection of the Duke of Bedford at Woburn Abbey. These were captured in August last in Clavering Island, situated off the coast of East Greenland, opposite Konig Wilhelm Land, in about latitude 74.5° N. When they arrived they were about the size of a rather large sheep, but by March of the present year (when the photograph here reproduced was taken) the solitary survivor had increased considerably in size, although the horns are only just becoming visible above the long hair of the sides of the forehead.

Probably most of my readers are more or less familiar with the general appearance of the adult Musk-Ox; but those who are not would do well to turn to its portrait in some work on natural history, or, still better, pay a visit to the British Museum at South Kensington, where both the mounted skin and the skeleton are exhibited. The absence of the large flattened, fibrous, and downwardly curving yellow horns which almost meet in the middle line of the forehead of the adult bull renders the aspect of the head of the calf very different. In other respects, however, the calves are very like the full-grown animals in general appearance, showing the same long, straight, and rather coarse hair, the conspicuous light-coloured "saddle" on the back, the white "stockings," the woolly triangular ears, the broad and almost completely hairy muzzle, and the entire burying of the rudimentary tail in the long hair of the hind-quarters. Owing, however, to the inferior length of the hair on the flanks, more of the legs is exhibited in the young than in the adult; and this enables the peculiarly heavy and massive form of the pasterns and feet to be better seen. Nothing was more curious about the calves at Woburn Abbey than their movements, which recalled those of a Polar Bear more than those of an ox or a sheep, the hocks being turned outwards in an altogether peculiar and distinctive manner. If this strange gait is also characteristic of the adult, it is probably adapted for progression on glaciers and other ice-coated surfaces; firmness of foothold being secured by the presence of a considerable amount of hair on the under surface of the foot.

But there is one respect in which the Clavering Island calves differ from the adult specimens exhibited in the British Museum, as well as from the description generally given of the species. This is the presence of a large patch of white hair on the forehead, as well as of an ill-defined white streak down each side of the face, and some scattered white hairs in the middle line between the muzzle and the eyes. When this feature was first noticed, it was thought that the East Greenland Musk-Ox might prove to be a race distinct from the West Greenland and American form, in which the face is, at least in most cases, uniformly dark brown. I have, however, received from Dr. A. G. Nathorst an illustrated account in Swedish of Musk-Ox hunting in East Greenland in 1899; and the photographs in this, although they are unfortunately on a very small scale and by no means distinct, seem to show that while some of the bulls have brown faces, in others there is a considerable amount of white, yet the large frontal patch of white which forms such a conspicuous feature of the calves is, of course, obliterated by the expanded bases of the horns. Accordingly, there seem to be no grounds for separating the Musk-Ox of East Greenland from its representative in West Greenland and Arctic America, although the two would appear to be completely isolated.



YOUNG BULL MUSK-OX. [*From a Photograph by the* DUCHESS OF BEDFORD.

To discuss the affinities of the Musk-Ox on this occasion would obviously be out of place; but my readers may probably like to be informed of some of the reasons which preclude its being classed either with the oxen or with the sheep. As regards the horns, it will suffice to say that they are quite unlike those of either of the groups in question. From the oxen the animal is broadly distinguished alike by the structure of its upper teeth, and also by its hairy muzzle. But this broad and hairy muzzle, in which there is a narrow, naked and granular area immediately above and between the nostrils, is equally unlike the narrow and short-haired muzzle of the sheep and goats. In the structure of its upper teeth, as well as in the presence of glands below the eyes and of only two mammæ in the female, the Musk-Ox is, however, much more like the latter group. But these two latter features* are of no great zoological importance, some sheep lacking face-glands, while one species of goat has four mammæ; and they in no wise serve to prove the existence of any close relationship between Musk-Oxen and sheep. It may be added that the aborted tail of the Musk-Ox separates it very widely from the oxen, in all of which this appendage is of great relative length; but in this respect the animal comes nearer to the sheep, nearly all the wild forms of which have short and stumpy tails. In the extremely late development of the horns (as attested by the survivor of the Woburn pair, which must now be at least a year old) the species seems to stand apart from both groups.

Judging from the photographs in Dr. Nathorst's account, it would seem that in East Greenland Musk-Oxen are commonly found in small herds of from eight to nine or a dozen in number. Their favourite haunts seem to be the gently sloping and boulder-strewn short valleys at the foot of the cliffs. Here they can be approached without much difficulty and shot down in the open, the members of the herd standing to gaze unconcernedly at the aggressor after one or more of their number has been shot down. When separated from their mothers, the young calves are by no means difficult to capture. I have been told by a friend that during an expedition to Greenland some officers succeeded in capturing a number of these calves, which they were carrying down on their shoulders to the coast; but the captive animals squealed so loudly as to attract the attention of all the Polar Bears in the neighbourhood, which thereupon started in pursuit and soon induced the unarmed captors to drop their booty!

CHEMICAL EVOLUTION.

A CHAPTER OF HISTORY.

By G. CECIL FRY.

THE whirligig of time brings its revenges, and the fanciful speculations of chemists about the elements, from the time of Prout onwards, have in recent years found confirmation in a science which no chemist of fifty years ago could imagine as having any relation to chemistry. Astronomy has contributed solid facts to what was merely an attractive theory; and the spectroscope, by which this result has been brought about, is an instrument equally important to both sciences.

There have been always scientists to whom the notion of sixty or seventy distinct kinds of matter was unthinkable. Ancient philosophers conceived all the manifold varieties of matter as but different manifestations of one "first matter," or protyle. The old division of matter into four "elements" was physical rather than chemical. The so-called elements were states or conditions of matter, not matter itself. The idea of "protyle" survived long in the minds of alchemists; but, after a period of oblivion, it was introduced to modern science with a new and special meaning.

In 1815 there appeared in the "Annals of Philosophy" an anonymous paper on the relations between specific gravities and atomic weights. The following sentence occurs in this paper: "I had often observed the near approach to round numbers of many of the weights of the atoms before I was led to investigate the subject."

This was merely a statement of fact or supposed fact; but in the next volume of the "Annals" a second paper on the same subject appeared, containing a full-fledged hypothesis. The following is the most notable part of the paper:—"If the views we have ventured to advance be correct, we may almost consider the protyle of the ancients to be realised in hydrogen; an opinion, by-the-by, not altogether new. If we actually consider this to be the case, and further consider the specific gravities of bodies in their gaseous state to represent the number of volumes condensed into one; or, in other words, the number of the absolute weight of a single volume of the first matter, protyle, which they contain, which is extremely probable, multiples in weight must always indicate multiples in volume, and vice versa; and the specific gravities or absolute weights of all bodies in a gaseous state must be multiples of the specific gravity or absolute weight of the first matter, protyle, because all bodies in a gaseous state which unite with one another unite with reference to their volumes."

This, then, was "Prout's hypothesis," as it was called when the identity of its author became known. It supposes, in brief, that the elements have been formed by successive condensations or polymerisations of hydrogen, the protyle from which all other forms of matter are derived.

Prout's idea was taken up with enthusiasm by Thomas Thomson, Professor of Chemistry at Glasgow. He supported it by a series of experiments which was probably the worst quantitative work ever published in chemical literature. Berzelius reviewed Thomson's results in 1827, and hinted very plainly that the experimental part of the work had been done at the writing desk; in other words, that Thomson had deliberately "faked" his figures in support of an untenable theory. This was doubtless untrue, but certainly Thomson's results were grotesquely inaccurate, and his experiments were carelessly performed by bad methods.

The atomic weight determinations of Berzelius appeared to have settled Prout's hypothesis altogether in the negative. But, in 1840, Dumas discovered that the great Swedish chemist had made a serious mistake in the atomic weight of carbon, which he found to be 12.2. Dumas found it to be almost exactly 12, and became in consequence strongly prepossessed in favour of Prout's hypothesis. His atomic weight determinations were done in the expectation of confirming it. The case of chlorine, however, seemed irreconcilable, and Marignac suggested a protyle having half the atomic weight of hydrogen as

* The existence of face-glands as well as the normal presence of only two pairs of mammæ has been recently discovered by my friend Dr. Einar Lönnberg, of Upsala.

XUM

the unit of atomic weights. This was the first appearance of the modified or "elastic" Prout, as it has been sarcastically named. A little later, Dumas proposed one-quarter of the atomic weight of hydrogen. Someone suggested ether as the hypothetical protyle, and gave it an atomic weight of .0001, a figure which is, of course, quite beyond the reach of analytical chemistry.

A theory that is being continually changed like this needs no disproof; but the magnificent work of Stas was destined to give the death-blow to both the original and the elastic Prout, as far as it could be given by exact analysis. Yet Stas himself began his work as a firm believer in Prout. He wrote:—"When I began my researches, I had an almost absolute confidence in the exactness of Prout's Law." His "absolute confidence" soon vanished, and he afterwards described the hypothesis as a pure illusion.

In a paper on the atomic weight of aluminium, published in 1880, Mallet criticised Stas' work on the ground that, though accidental errors had been practically abolished, there might still remain undetected constant errors. This is highly improbable, considering the variety of methods used by Stas; and, even if true, it would prove little or nothing. For while the detection of a constant error may bring one element nearer the required value, it is just as likely to take another element farther away from it. Oxygen is a case in point. Since the date of Mallet's paper it has fallen out of the list of elements whose atomic weights are approximate whole multiples of that of hydrogen. The work of Keiser, Cooke and Richards, Rayleigh, Scott, Morley and others, leaves little doubt that the atomic weight of oxygen is less than 15.9, and is probably very near to 15.88.

There is nevertheless a real and striking approximation of many atomic weights to whole multiples of that of hydrogen. In the paper already referred to, Mallet gave a list of eighteen elements whose atomic weights have been most accurately determined. Ten of these atomic weights were within 0.1 of whole numbers. (As already stated oxygen has fallen out of this list.) The chances against this occurring accidentally are more than 1,000 to 1. F. W. Clarke extended this argument to sixty-six elements, of which forty have atomic weights falling within the 0.1 limit of variation. He says that forty agreements include nearly all the trustworthy determinations.

The case seems to stand thus:—Prout's hypothesis in its original form, and in the modifications proposed by Marignac and Dumas, is untrue. But there is, nevertheless, a certain approximation to it, which is scarcely likely to be quite accidental.

All this, however, does not really affect the wider question, whether the elements are primordially distinct bodies, or whether they are derived by aggregation from a simpler form or forms of matter. For a long time there was only negative evidence on both sides; but for a good many years now positive evidence has been accumulating in favour of the evolution of the elements.

To begin with, the only evidence in favour of the elementary nature of the elements is purely negative. The definition of an element is based, not on any attribute of the thing defined, but on the limitations of human power. It is merely a confession of impotence.

The progress of science is, in general, a process of simplification. Larger and larger groups of facts are brought under more and more general laws. Thus chemists have, during the last two centuries, reduced the millionfold chemical complexity of heaven and earth to, say, a seventyfold complexity. Is there to be at this point a solution of continuity, or is the simplification to go on to its logical conclusion?

Physics, it may be noted, takes small account of chemical differences. All forms of matter alike obey the laws of physics in the same way. Graham, who was both physicist and chemist, was strongly impressed by this physical unity underlying chemical diversity. He wrote in 1863:—"It is conceivable that the various kinds of matter, now recognised as different elementary substances, may possess one and the same ultimate or atomic molecule existing in different conditions of movement. The essential unity of matter is an hypothesis in harmony with the equal action of gravity on all bodies."

Again, the relations between the atomic weights of the elements render their complete independence of one another hardly supposable. The greatest generalisation made in chemistry since the atomic theory is "the properties of the elements are functions of their atomic weights"; and the prediction of the properties of gallium, scandium and germanium was a greater triumph to chemistry than was the prediction of Neptune to astronomy.

The work of Sir William Crookes on the rare earths is of the highest significance. He has shown that a substance like yttrium, which from every chemical point of view behaves as an element, can by repeated fractional precipitations be split up into several groups having different spectra, and presumably different atomic weights. The process of fractionation implies differences among the "elementary" atoms, and a possibility of selection. Crookes writes thus about didymium, after splitting it up into neodymium and praseodymium:—"Didymium is certainly a compound. It has a definite atomic weight and well-defined salts, and has been closely scrutinised by some of the ablest chemists in the world. But it emerged as a seeming element from every trial."

The distribution of the elements in the earth also deserves consideration. How can this be explained apart from the theory of evolution? Why, for instance, should nickel and cobalt be always found together? Why should the platinum group of metals and the rare earths be so localised and so rare? Why should meteoric iron always contain nickel and cobalt, and very often manganese and chromium as well — all elements of similar properties, and nearly equal atomic weights? These facts are just what one would expect if these elements had been formed under nearly identical conditions from simpler forms of matter.

The remainder of the evidence is more positive in character, and is chiefly due to the spectroscopic researches of Sir Norman Lockyer. So long ago as 1876, Lockyer showed that the spectrum of calcium varies at different temperatures, and that the changes brought about by rising temperature are exactly parallel to the changes in the spectrum of a compound as it is gradually dissociated by heat. In short, this element behaves, spectroscopically speaking, as a compound.

The spectrum of iron is well known to be enormously complex; and it ought to be noticed, in passing, that this complexity is in itself some evidence against the elementary nature of iron; it is difficult to imagine an indivisible atom vibrating in so many hundreds of different ways. But the iron lines in the solar spectrum

differ in many ways from those in the terrestrial spectrum. Lockyer has found that on certain days certain lines are absent; on other days other lines; and so on in almost endless variety. The lines of a sun-spot are different from those of a prominence. Some of the iron lines may be bent, indicating rapid motion of the luminous material, while other lines in the same spectrum remain straight, indicating comparative rest. The lines indicating motion vary from place to place and from day to day. The set of bent lines in a sun-spot is different from the set of bent lines in a prominence. In short, an indivisible atom can move and remain at rest at one and the same time! The only feasible explanation of these facts seems to be that the iron has been dissociated by heat, and that the constituents have been partly separated.

The idea that each substance has a spectrum entirely and specially its own is untrue. Many lines of different metals coincide. Thus out of sixty-two lines of iron in the region 39 to 40, no less than forty-four coincided with lines of other metals.

It has also been shown that many elements have fluted as well as line spectra. The former are characteristic of low temperatures. As the temperature rises, the lines appear one by one. The series of spectra so obtained is exactly parallel in appearance with the series obtained when a known compound is dissociated by heat. There is a gradual thinning-out of bands and appearing of lines.

The witness of the stars to elementary evolution is much more striking and direct. Lockyer, long ago, pointed out in a general way that the hottest stars have the simplest chemical composition, and he has recently developed this subject much more fully. In a lecture delivered in the spring of last year he said:—"Dissociation reveals to us the forms the coming together of which has produced the thing dissociated or broken up by heat. If this be so, the final products of dissociation or breaking up by heat must be the earliest chemical forms. Hence we must regard the chemical substances which visibly exist alone in the hottest stars as representing the earliest evolutionary forms."

The lecturer then gave details concerning the increase of chemical complexity in stars with decrease of temperature:—"We find that in the hottest stars we get a very small number of chemical elements; as we come down from the hottest star to the cooler ones the number of spectral lines increases, and with the number of lines of course the number of chemical elements. In the hottest stars of all, we deal with a form of hydrogen which we do not know anything about here (but which we suppose to be due to the presence of a very high temperature), hydrogen as we know it, the cleveite gases, and magnesium and calcium in forms which are difficult to get here; we think we get them by using the highest temperatures available in our laboratories. In the stars of the next lower temperature we find the existence of these things continued in addition to the introduction of oxygen, nitrogen and carbon. In the next cooler stars we get silicon added; in the next we get the forms of iron, titanium, copper, and manganese, which we can produce at the very highest temperatures in our laboratories; and it is only when we come to stars much cooler that we find the ordinary indications of iron, calcium and manganese and other metals. All these, therefore, seem to be forms produced by the running down of temperature. As certain new forms are introduced at each stage, so certain old forms disappear."

This chain of facts, thus briefly stated, confirms in a most striking way the chemical speculation that has been going on more or less continuously since the time of Prout; and gives solid support to the theory of the evolution of the elements. The only mistake that Prout made—a very natural mistake at the time—was in taking hydrogen as his starting point. For if evolution of the elements has really taken place, some modification of Prout's hypothesis must be true. The atomic weights of the elements must be multiples of that fraction of hydrogen which may result from the dissociation of hydrogen. The fact that the verification of this is beyond the reach of analytical chemistry is beside the question; but it is worth noting that some of the most accurate atomic weight determinations ever made were due to the controversy over Prout's hypothesis, which has, in this way, at least, borne practical fruit.

It has long ago been noticed that the essential elements of living matter are all of relatively low atomic weight. Sir Norman Lockyer has also pointed out the interesting fact that these elements are precisely those found in the hottest stars. In other words, organic evolution began among the earliest and simplest chemical forms; and the marvellous mobility and plasticity of the protoplasmic cell are due to its being formed from the simplest, and, presumably, the most mobile and most plastic of the elements. We have here "a quite new bond between man and the stars."

Before biological evolution could begin, there was a chemical evolution like it in many respects, characterised by the same progress from simplicity to complexity, by the appearance of new forms and the disappearance of old ones. As the rocks are divided into strata according to the fossils they contain, so the stars can be divided into "strata" according to their chemical composition and the period of evolution they have reached.

This chemical evolution comes very exactly under the philosophical definition of evolution in general. It is a progress from "an indefinite, incoherent homogeneity to a definite, coherent heterogeneity."

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

The residua and strainings obtained from ordinary tap water will provide the microscopist with an abundance of material for examination. Among the organisms that he will probably meet with are the fat little rotifer, *Triarthra longiseta*, hobbling along on his long delicate stilts in company with the pretty little long-spined *Anurea longispina*. The Vorticellidæ and Entomostraca are often in great force, with diatoms and desmids innumerable. *Dinobryon sertularia*, a curious compound flagellate organism, like animated ears of barley, though not so numerous, are invariably present in greater or lesser numbers. A bag made of several thicknesses of very fine muslin and tied on the water tap, so that the water strains gently through it, is a rough and ready, but, on the whole, a satisfactory way of capturing them.

A practical way for obtaining crystals from dog's blood is suggested by Dr. S. Waterman. Defibrinate and mix water in equal parts to each volume of blood. Add to four volumes of the blood solution one volume of alcohol. Set the mixture to rest for twenty-four hours at a temperature of 0° or less. The crystals formed are filtered off, pressed, dissolved in the smallest quantity of water, say 25 to 30 per cent., exposed to a temperature of 10°, and left undisturbed for twenty-four hours. The whole solution will be found converted into a crystallised mass.

The production of hæmoglobin crystals is surrounded at times with more or less difficulty, owing to the rapidity with which

XUM

the hæmoglobin decomposes. A simple method is to allow the blood to coagulate, express the serum, and separate the fibrin by filtration. Through this solution pass a current of oxygen for half-an-hour, and then carbonic acid gas for ten or fifteen minutes. Crystals may be readily obtained from the blood of the dog and other animals by adding alcohol in small quantities during the passage of the gas currents.

Sunlight is par excellence the best source of illumination for photomicrography. A good substitute for a heliostadt is a fair-sized mirror swinging on a double axis, and capable of being regulated by hand. No difficulty is experienced in keeping the light centred, as exposures by sunlight are of such short duration. When using sunlight, care should be taken to pass the rays through a cell of saturated solution of alum, in order to absorb the heat rays, otherwise serious damage may be done to the objective and the sub-stage condenser.

After sunlight, diffused daylight from a window with a northern exposure is the next best light at the disposal of the photo-microscopist, but when it is necessary to use artificial illumination, acetylene gas or magnesium wire will be found to give satisfactory results. Some objects are better shown under a diffused light, such as may be obtained by the interposition of a ground-glass screen, or near a window without the aid of a condenser. If the colour of the object be dark, or reflects but little light, the bull's eye should be focussed on the specimen, care being taken to avoid glare or excess of illumination, which will result in a confused image in the negative. With some objects, the Lieber kuhn may be used advantageously, with others the parabolic reflector, but the majority yield better results under the most simple forms of illumination.

Potato-agar is suggested as a good cultivating medium for thermophilous bacteria. It is prepared as follows :—Potatoes are steamed, peeled, and pounded. To 100 grammes of potato add one litre of water, steam the mass for half an hour and then filter. To the filtrate add two per cent. of agar and autoclave the whole for fifteen minutes. It has been found advantageous to add one per cent. of salt. After neutralization with soda, and further steaming, filter the potato-agar into test tubes and sterilize once more.

To prepare photo-micrographs of diatoms, first photograph the diatoms with a magnification of not more than 100 diameters, then enlarge so as to obtain a photograph of 500 diameters, proper for photo-printing. The finest details are thus brought out, which otherwise are invisible to the eye in the smaller photograph. Even forgeries in legal documents can be discerned by using enlargement pictures, which microscopically are not visible if printed on bromide or velox paper.

Magnesium as an illuminant for photo-micrography is not a new idea. It was used for this purpose by Dr. R. L. Maddox as far back as 1864, but owing to the expense of its production it never became really popular. Magnesium is prepared commercially from the melted chloride of electrolysis, or by metallic sodium, and, when heated either in air or oxygen it first glows and then burns with a bluish-white dazzling flame. The experiments of Bunsen and Roscoe have shown that the sun at its zenith has only 36·6 times more chemical brightness, and 524·7 times more visual brightness than magnesium. It is therefore suitable in a special degree for photographic purposes, and now that the price of the metal, either as bar, wire, ribbon, or powder is so low, there is every inducement to the photo-micrographer to call in its aid.

The following method of preparing sections of the teeth of fish is suggested by Mr. A. Underwood, of the Leicester Square Dental Hospital. Sections of fishes' teeth should not be ground, but the jaws and teeth should be decalcified in a 5 per cent. solution of chromic acid, or a 10 per cent. solution of hydrochloric acid. After sections have been cut and stained, they should be well washed in distilled water, dehydrated for three minutes in absolute alcohol, cleared in oil of cloves, and mounted in Canada balsam. Carmine is the best stain for fishes' teeth.

In collecting any fleshy fungi, care should be taken to obtain all the fleshy structure, as some of the most important characters are only to be observed in the basal parts. To remove the basal portion entire, a knife or small trowel should be employed. Specimens that are broken off short with the ground are seldom of much value for scientific purposes. Fleshy ascomycetous fungi can best be preserved in alcohol, but many of them may also be satisfactorily dried. It is well, when fungi gathering, to take a stock of tissue paper to wrap the specimens in. Each form should be wrapped up separately so as to prevent breaking, or soiling from contact with one another.

A good dead black for varnishing the interior of microscope tubes and cameras may be made by mixing two grains of lamp-black with just enough gold size to hold the lamp-black together. Add the size drop by drop from a lead pencil. After the lamp-black and size are thoroughly mixed and worked up, add twenty-four drops of turpentine and work up again.

To the current issue of the journal of the Quekett Club Mr. A. Earland contributes an interesting article on the structure, distribution and life history of the Radiolaria, illustrated by three plates from the Report on the Radiolaria of the "Challenger" Expedition.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* KNOWLEDGE.]

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

GIACOBINI'S COMET.—This object is now about 7 degrees south of the star Beta Andromedæ, and is moving to the north-west It is rapidly becoming more favourably situated, and is approaching the earth. The twilight is now, however, very strong, and the comet being a faint one, a powerful telescope must necessarily be employed in its observation. The comet will be presented under its best aspect during the absence of moonlight in the last half of July. At the middle of that month the apparent brightness of the object will be about twice that at discovery on January 31. In February the comet was of the 13th magnitude, and described as a somewhat difficult object on account of its faintness by several of the observers who were fortunate to obtain views of it. The following is an ephemeris of the comet by A. Berberich (Ast. Nach. 3636) :—

Date.	R. A. h. m. s.	Dec. ° ′	Distance in Millions of Miles.
June 2 ...	1 3 53	+ 28 36 ...	174
„ 6 ...	0 57 49	+ 30 11 ...	167
„ 10 ...	0 50 40	+ 31 52 ...	161
„ 14 ...	0 42 9	+ 33 39 ...	155
„ 18 ...	0 31 59	+ 35 31 ...	148
„ 22 ...	0 19 43	+ 37 29 ...	140
„ 26 ...	0 4 50	+ 39 31 ...	134
„ 30 ...	23 46 53	+ 41 32 ...	128
July 4 ...	23 25 11	+ 43 27 ...	122

COMET DISCOVERERS.—The close of the last century terminated the interesting and numerous series of cometary discoveries effected by Miss Caroline Herschel, and by Messier and Mechain. But Pons very shortly afterwards came into the field and eclipsed all the efforts of his predecessors in this productive line of work. Originally a door keeper at the observatory at Marseilles, the instruction and encouragement he received from the director Thulis (discoverer of Encke's Comet at its return in 1805), resulted in his taking up the search for comets, and his perseverance and genius for the work enabled him to make a remarkable number of discoveries. Now, at the close of the nineteenth century we have many successful comet hunters, including Brooks, Swift, Perrine, and Giacobini. Among those who have earned special distinction in this branch during the last half of the century are Tempel, Winnecke, Donati, and Klinkerfries, who have "gone over to the majority." Others including Barnard, Borelly, Coggia, H. P. Tuttle and a few others of less renown are still living though engaged in other astronomical work. When the history of cometary discovery in the nineteenth century comes to be written due praise will be given to Pons, Tempel, Brooks, Barnard, Swift, and Winnecke, who have proved themselves the most successful workers in this attractive and exciting field.

THE APRIL METEORS.—The weather was clear and the evening sky moonless at the epoch of this shower, but it did not return in any strength. Meteors generally were rare—a characteristic of the Spring season—and the Lyrids only reappeared in sufficient numbers to prove their existence. Prof. A. S. Herschel watched the sky at Slough for short intervals on April 15, 16, 17 and 18, and during an aggregate of 7 hours of observation only recorded 7 meteors. On April 19 he saw 12 meteors in 4½ hours. On April 20, 25 meteors in 5 hours, and on April 21, 35 meteors in 4¼ hours. The true cometary Lyrids from a radiant at 270° + 32° were in very weak evidence, only 3 or 4 being seen, while about 12 were from a good radiant at 277° + 30°. Outlying radiants were in Draco and Lyra at 261° + 48° and 280° + 47°, comprising between them 15 or 20 fine

streaked meteors. Mr. A. R. Hinks at Cambridge watched the sky for several hours on April 20, but saw no Lyrids, though a definite shower appeared to be proceeding from the region of Beta Draconis. Mr. A. King at Leicester made observations on several nights and registered a number of meteors, but there were only a few Lyrids, and these showed a radiant at 274° + 33°, being a little east of the usual position, and confirming fairly well Prof. Herschel's centre at 277° + 30°. As the radiant is probably a morning one, the mean of the two positions would nearly represent its usual place on April 21, but would be several degrees east of its position on April 19. In observations of this and similar showers it is therefore of great importance to keep the observations for each night separate, and determine the individual radiants for successive dates if there are sufficient materials for the purpose. This is, however, not often the case, as the Lyrids form a very short-lived shower, and one very meagre in the distribution of its meteors. They are usually rare except on the night of maximum, and even then the shower is so poor as to be scarcely distinguishable. Two meteors of the display appear to have been doubly observed this year. On April 20 at 10h. 19m. a small meteor of about 4th mag. was recorded by Prof. Herschel at Slough, and by Mr. H. Corder at Bridgwater. The former found the radiant from the combined tracks was at 257° + 40°, and the heights from 34 to 30 miles over a point N.W. of Basingstoke, Hants. The elevation is unusually low, but there seems little doubt as to the identity of the objects. A meteor which appeared on April 21 at 10h. 32m. of 3½ magnitude, was seen by Prof. Herschel and by Mr. A. King at Syston, near Leicester. Prof. Herschel places the radiant in 180° − 25°, and gives the heights of the meteor as from 63 to 53 miles from over Woodstock to near Leicester. The path was 54 miles long, and the speed about 15½ miles per second, which agrees very well with the theoretical velocity, which would be 15 miles per second.

FIREBALL OF MARCH 28.—A magnificent meteor was seen on March 28 at about 8h. 32m. by Mr. Astbury at Wallingford, Mr. Crommelin at Blackheath, Mr. G. T. Davis at Reading, Mr. Knight, Bishop's Stortford, and other observers. It was several times brighter than Venus, and lit up the sky with a vivid flash. Prof. Herschel has discussed the observations and finds the radiant at 182° + 43°, and heights of from about 60 to 35 miles over the S.E. part of England. The observations, however, disagree in some essential particulars, and it does not seem possible to derive a perfectly satisfactory result from them. A few additional descriptions of this fine meteor would be very valuable, and it is to be hoped that they will be forthcoming.

THE FACE OF THE SKY FOR JUNE.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 3.51 and sets at 8.5; on the 30th he rises at 3.48 and sets at 8.19. The sun enters Cancer, and Summer commences at 10 P.M. on the 21st. Sun spots are still occasionally to be seen.

THE MOON.—The moon will enter first quarter at 6.59 A.M. on the 5th; will be full at 3.39 A.M. on the 13th; will enter last quarter at 0.57 A.M. on the 20th; and will be new at 1.27 A.M. on the 27th. Among other occultations during the month, that of Saturn, on the 13th, will be of special interest. Particulars of the three occultations visible at Greenwich are given below:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
June 2	κ Cancri	5·0	8.33 P.M.	120	82	9 35 P.M.	287	247	5 6
,, 7	D.M. −16° 3570	6·0	9 58 P.M.	156	135	10.55 P.M.	251	222	10 7
,, 13	Saturn	—	9.40 P.M.	89	116	10.52 P.M.	265	283	16 7

There will be a partial eclipse of the moon, beginning just before it sets on the morning of June 13th. The magnitude of the eclipse is 0.001, and the moon is only in the shadow proper for about 7 minutes. First contact with the shadow takes place at 3.24 A.M., and last at 3.31 A.M., the moon setting at 3.54 A.M. The shadow will fall on the lower part of the moon, to the left.

THE PLANETS.—Mercury is an evening star, but at this season one can scarcely expect to observe him.

Venus is an evening star and attains her greatest brilliancy on the 1st. The planet will be stationary in Gemini on the 16th, after which it will rapidly approach the sun and be lost to our view until it reappears as a morning star. On the 15th one-seventh of the disc will be illuminated.

Mars is a morning star, but as it rises less than two hours before the sun during the greater part of the month no further data need be given.

Jupiter is fairly well placed for observation from dusk until the early morning hours. His path is a short westerly one in Scorpio, and at the end of the month will be very near to Beta Scorpii; on the 30th he will be 1½ minutes following and 18' south of the star. The apparent diameter on the 15th is 41".6, and the meridian passage on the same date is at 10.32 P.M. The satellite phenomena are most interesting, at convenient hours, on the 1st (8.19—11.0), 3rd (9.35—11.56), 4th (8.44—10.45), 8th (10.33—12.58), 11th (8.27—12 43), 17th (10.26), 18th (10.13—12.57), 19th (10.13), and 29th (9.49—10.58).

Saturn is visible throughout the greater part of the night, rising about 9.30 on the 1st, and about 7.30 on the 30th. He is in opposition on the 23rd. On the 13th the planet will be occulted by the moon. During the month the planet describes a westerly path between Mu and Lambda Sagittarii. On the 19th, the diameter of the ball is 17", while the outer major and minor axes of the outer ring are respectively 42".6 and 18".9. The northern surface of the ring is visible.

Uranus is in opposition at 11 A.M. on the 1st, when he rises at 8 P.M. During the month he describes a short westerly path in the south-western part of Ophiuchus, a little to the south-east of the star Omega in that constellation.

Neptune is not observable, being in conjunction with the sun on the 18th.

THE STARS.—About 10 P.M. at the middle of the month Cygnus will be in the east; Lyra will be high up, a little to the south of east; and Aquila will be in the same direction but lower. Near the meridian will be Hercules, Corona, Ophiuchus, Libra, and Scorpio. Arcturus will be a little west of the meridian, Virgo rather low in the south-west, and Leo almost due west.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of May Problems.

No. 1.

(N. M. Gibbins.)

1. Kt to K5, and mates next move.

No. 2.

(W. Clugston.)

1. R to Kt4, and mates next move.

CORRECT SOLUTIONS of both problems received from W. de P. Crousaz, Alpha, G. A. Forde (Capt.), J. Humble, J. W. Meyjes, G. W. Middleton, J. Baddeley, W. F. Denning, W. Clugston, H. C. Jelliman.

Of No. 1 only, from Otto Schachel.

XUM

Of No. 2 only, from D. D., A. Gorham.

D. D.—Kt × P will not solve No. 1.

A. GORHAM.—If 1. Kt to K3, Q × Q, and there is no mate.

OTTO SCHACHEL.—None of your solutions to No. 1 will work. Black's best defence must be assumed in every case.

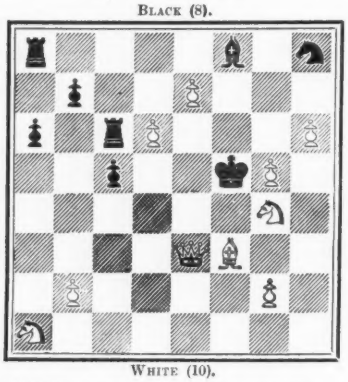
W. CLUGSTON.—Many thanks. You will see that Mr. Gundry's problem appears below.

PROBLEMS.

No. 1.

By B. G. Laws.

BLACK (8).



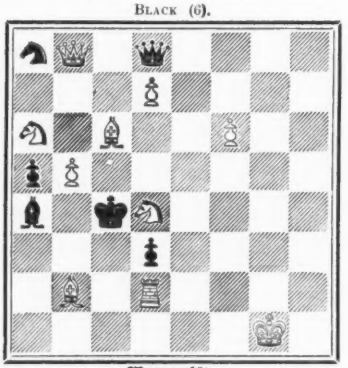
WHITE (10).

White mates in three moves.

No. 2.

By W. H. Gundry.

BLACK (6).



WHITE (10).

White mates in two moves.

CHESS INTELLIGENCE.

The Anglo-American inter-universities cable match has resulted in a decisive win for the English universities. The score was as under:—

ENGLAND.		AMERICA.	
Tattersall (Camb.)	½	Rice (Harvard)	½
Softlaw (Camb.)	1	Hunt (Princeton)	0
Ellis (Oxon.)	1	Sewall (Columbia)	0
George (Oxon.)	1	Cooke (Yale)	0
Soddy (Oxon.)	0	Hopkins	1
Wiles (Oxon.)	1	Austell	0
	4½		1½

The Paris International Tournament is just beginning as we go to Press. The entries include Lasker, Pillsbury, Maroczy, Janowski, Schlecter, Brody, Burn, Mason, Tchigorin, and about twelve others, including perhaps Blackburne.

The death of Rudolph Charousek deprives the world of a brilliant player who might easily have risen to the championship. Before his death, at the age of 27, most judges would have placed him among the first five living players. Charousek won the Berlin tournament and was second to Tchigorin at Budapest, and to Burn at Cologne, the last tournament in which he took part.

The Hastings Chess Festival was brought to a successful conclusion last month. Messrs. Blackburne, Lee and Teichmann were the masters engaged, five drawn games being the result of their consultation games. Mr. Teichmann's simultaneous performance resulted in a score of 15 wins and 5 draws out of 20. Mr. Blackburne, blindfold, was also in excellent form, winning 5 games and drawing one. In the duplicate series of consultation games Mr. Teichmann made the best score, winning both his games, while Messrs. Blackburne and Lee won one and drew one.

After an adjournment over Easter the City of London invitation tournament was brought to a conclusion with the following score:—

R. Teichmann	9½	First prize	£20
J. Mason	9	Tie for second and third prizes	£12
I. Gunsberg	9		£12
W. Ward	8½	Fourth prize	£8
L. Van Vliet	8	Fifth prize	£6
J. H. Blackburne ...	7½	Sixth prize	£4
T. F. Lawrence... ...	6	Seventh prize	£2
F. J. Lee	5		
R. Loman	4½		
A. Tietjen	4		
E. O. Jones	3½		
T. Physick	2		
S. Passmore	1½		

Messrs. Teichmann and Mason both started badly. Mr. Blackburne, on the other hand, secured a good lead at the start, but after the adjournment was severely handicapped by illness. Mr. Ward is to be congratulated on an excellent performance; to be one point only behind the first prize winner is a most creditable achievement in such company. Mr. Gunsberg showed that he has lost little of his former skill, though he retired from serious chess some years ago. Mr. Loman, on the other hand, has done better things in his time.

The annual tournament of the Southern Counties' Chess Union will be held this year at Bath, the date fixed being September 3 to 12. The Scottish Association tourney has resulted in a tie between Mr. D. Y. Mills, the perennial holder of the trophy, and Dr. Macdonald; the tie is to be played off during the summer. The championship of the Southern Counties Chess Union has again been won by Surrey, who defeated Gloucestershire in the final tie.

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